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Advancing Highway Maintenance

A DEMONSTRATION of the results of proper maintenance of a macadam road, if on a scale sufficient to attract national attention, ought to have a decidedly beneficial effect on highway work throughout the country. The importance of maintenance was never better recognized than it is to-day, and the practice in some of the Eastern States is admirable. As the regular work of State organizations it does not receive extensive notice in the public prints. It is fortunate, therefore, that before long the country will have a demonstration road of such importance and lending itself so well to publicity that it may become the text for many newspaper preachments on maintenance. The American Highway Association will take over the management of a through route from Washington to Atlanta, and will provide the facilities whereby the Office of Public Roads, at no expense except the time of some of its men, may exercise supervision of the maintenance work. The road is practically completed for the entire distance. Most of it is macadam, but part of it is sand-clay. The highest praise is due the American Highway Association for its initiative. It is thereby aiding materially the advance of highway practice in the United States.

Another American Invasion

THE selection of Henry W. Thornton, of the Long Island Railroad, as general manager of the Great Eastern Railway of England, and more especially the remarks of the latter road's chairman, Lord Claud Hamilton, should furnish food for reflection for those who can see no good in American methods of railroad management. Mr. Thornton, a man only forty-two years old, worked his way up by the usual course on the Pennsylvania system, leaving the engineering branch after seven years to take up operation. Confessedly a thoroughly capable man, there is nevertheless little apparent in his past record to differentiate him from dozens of other American railroad officials. Even on his own road, with barely a third of the mileage of the Great Eastern, he had not attained to the rank of general manager. Without reflecting on his ability, it can reasonably be said that he was one of a fairly numerous class. Yet in announcing his choice Lord Claud stated that the dearth of proficient men in the British railway field made the selection of an American necessary. He lays this to inflexibility, which compels a young man to remain in the department in which he starts, and to Government legislation and inspection. Too much stress, he asserts, is laid on seniority and too little on merit. His remarks have been severely criticised by the British press. If Mr. Thornton succeeds, and convinces England that he has done so, he will have scored a still greater triumph for American methods of operation.

New Schedule of Professional Fees

AMONG the subjects which have been most widely discussed in engineering circles for the past year or so is the matter of charges for professional services. A number of organizations of technical men have already adopted codes of ethics and schedules of fees, and the latest one to join the ranks is the Connecticut Society of Civil Engineers, which accepted at its annual meeting on Feb. 10 the committee report published in the Engineering Record of Feb. 7, page 154. The new schedule provides for charges on the basis of a percentage of the cost of the work, a fixed sum, or a per diem rate. The charges range from 1 per cent of the cost of the work for preliminary studies to 12 per cent for full professional services. On the per-diem basis the remuneration may be from $25 to $100 for expert services, reports, consultations and opinions, and from $15 to $50 for less exacting services. A commendable feature of the new code is its recognition of the importance of good construction: "Good designing may be vitiated by poor construction, especially in any work which requires careful supervision and inspection during its progress, such, for example, as reinforced concrete work. For this reason it is for the best interests of the client that the engineer be given full direction of the work during the construction period, or, if this is impracticable, that the client employ experienced inspectors approved by the engineer and working under his general supervision."

Cost of Congestion

REFERENCE has already been made in these columns to the London traffic studies being made by a specially organized branch of the British Board of Trade. Its sixth report was rendered last month, though actually dated Oct. 1 last. It discusses the motorbus at considerable length and shows that the bus, proportionately, is less responsible for accidents than the lighter motor traffic. It shows, moreover, that the congestion is not increasing in the same proportion as the volume of traffic, due, doubtless, to the greater mobility of motor vehicles and the excellence of the traffic regulations. The most interesting part of the report, however, is summarized in this sentence: "When regulations have done their work, the ultimate remedy lies in widening existing streets, or in piercing new ones." The cost of this procedure—already under way so far as widening is concerned—is appalling, and American cities which are skyscraper mad should ponder London's situation and see to what they are coming. Of the two schemes—widening and new streets—the report prefers the latter, for the opening of a new street does not interfere with traffic, interferes but little with business in the shops affected, takes parts of property less valuable than the fronts (which are required in widening schemes), gives an opportunity of increasing property values, thus recouping part of the cost, and, finally, adds an entirely new artery, which is much better than a widened one, unless the widening is excessive. Another recommendation of the report may in some cases be applicable to American conditions. Quite a number of town-planning schemes are projected in an annular belt between the 6 and 9-mile circles centering about St. Paul's Cathedral. The report urges that the roads therein be laid out with a view to co-ordination with the arterial ways to the center of the city, thus relieving congestion. American town planners have this matter well in mind, but its emphasis by the London traffic branch is worth repeating. Above all, though, the penalty that London must pay to relieve its congestion should be borne in mind. Our cities are in the making. The remedies should be applied now, through restrictions which will prevent the occurrence here of conditions now existing abroad.

Making Dams Safe

NOT all engineers seem to appreciate the necessity of providing adequate cutoff walls underneath structures forming reservoirs. About 60 per cent of all dam failures is due to insufficiency in the examination of the foundation. During the first month of this year two dams were washed out—the Stony River dam, on Jan. 15, and the Horse Creek dam, on Jan. 29. Both failures can be traced to percolation of water under or through the structure. No one should attempt to construct a dam without first examining carefully the prevailing soil formation. The next step is to provide adequate means for preventing seepage through fissures in the rock or seams between different strata. It should not devolve upon the engineer in charge of construction to determine what measures should be taken to accomplish this. Such questions should be answered by thorough preliminary investigations in the form of borings and test pits. Earth dams often form an adequate seal even without a core wall because of their broad bases, but care must be used in preventing seepage along the outside of conduits and other structures extending through the dam. To design the outlet conduit with a smooth surface violates good practice. Frequently seepage along such a structure cannot be absolutely prevented, but it is not difficult to make this seepage follow such a long route that the hydraulic losses are excessive. This will deprive the percolating water of its eroding force. Care should also be taken in depositing the material in earth dams. In the Horse Creek dam, the failure of which was described in this journal last week, the material was apparently placed in horizontal layers. The rule to provide as long seams as possible to prevent erosion due to seepage also applies here. Such seams should never be made horizontal, for that will give them a minimum length. The materials, if deposited in a dry or semi-dry condition, should be placed along slopes, and these slopes changed from time to time so that no seam will extend through the dam. Earth dams should not be built with a "wet" gate tower—one that always stands full of water—located near the center line of the structure. Such a tower makes it impossible to drain the upstream part of the conduit and inspect it. It makes no difference whether a "dry" or "wet" tower is built; it should always be placed as near the upstream toe of the dam as possible and should be so designed that every part of it and the conduit can be inspected at any time.

State Control of Municipal Water Supplies

It is a general principle of successful administration that authority and responsibility must go together. From the time municipalities began to operate public water supplies until about twenty-five years ago they enjoyed full authority over their affairs and were alone responsible for them. Since then there has been a growing tendency to take authority in certain directions from the municipalities and to give it to State officers, particularly to departments of health.

One of the earliest acts of State control was that provided by the commonwealth of Massachusetts in 1888. It was enacted that the State Board of Health should have the general oversight and care of all inland waters, should consult with and advise the authorities of cities and towns having or intending to introduce systems of water supply, drainage or sewerage, and it was further provided that all petitions to the legislature for authority to introduce a system of water supply, drainage or sewerage should be accompanied by a copy of the recommendation and advice of the said board thereon. This most important act, which has remained in effect without substantial change up to the present time, gives the State Board of Health advisory power only. No direct authority or control over local works was given.

Since that time many other States have passed laws more or less similar in character, but usually conferring greater, and sometimes very much greater, authority upon State officers. Two main steps in this increased authority may be noted. In the first, the State officer or board is given a veto power upon plans which must be submitted; in the second, the State officer or board is authorized to propose and may require the construction of works.

The first of these steps has been most widely used, and a considerable number of the more densely populated States now have some requirement of this kind. Even in Massachusetts, where the general law of 1888 remains, special provisions requiring the approval of plans have been incorporated in many special acts relating to individual water supplies. This veto power wisely exercised has, no doubt, resulted in preventing much unwise and unsuitable construction.

Under other conditions, as a result of mistaken notions, it has occasionally resulted in preventing the execution of proper and needed projects. There has been some suspicion that even the Massachusetts State Board of Health has been too slow in recognizing developments in the art of water supply and in permitting the application of new methods. The use of sulphate of copper to hold in check the organisms that grow in open reservoirs and produce tastes and odors has not been sanctioned. Several plans for the mechanical filters that afford the only known method of decolorizing highly colored swamp waters have been rejected, and the use of methods of disinfection has not been encouraged. All these methods of well-tried and recognized worth have been freely used in other parts of the country with advantage. It is clear that the veto power, while valuable in many cases, may be in others a limiting condition not favorable to real progress.

Of much more radical character is the legislation which gives State officers the power to suggest or require the construction of new works by municipalities. Only a few States have gone so far as this. From the standpoint of administration it is certainly a very questionable expedient to allow a State officer having no responsibility for results to dictate the course that a city must follow. One can easily imagine that it might lead to the State control of water-supply systems at the disastrous expense of local authorities and of taxpayers, and that the disorganizing effect might grow to be so strong that even the strongest works could not withstand it.

Few laws of this kind have been tested in the courts. In one State a considerable proportion of the municipalities are more or less in contempt because of failure to comply with State orders in regard to sewage disposal, but no action in the courts has been brought to enforce them.

Under these conditions the decision of the Supreme Court of Ontario, in regard to the Ottawa water supply, is refreshing. Ottawa needs a new water supply. Because of local contentions all efforts thus far made through usual local channels to select and authorize a new water supply have failed. Acting under authority of provincial law, the health officer of the province ordered the city to construct a new water supply for which a project had been made. The court holds that this procedure is not valid; and the city must authorize the new works in the regular way before they can be built. The decision is sound common sense and will tend to limit the extension of a practice which, if continued, might prove disastrous.

Cost Plus Fifteen Per Cent

An important factor in the comprehensive plans for extending New York City's rapid-transit systems is the third-tracking of the Second, Third and Ninth Avenue elevated railway lines. These structures were begun about forty years ago and have been extended from time to time until, long since, they stretched from the southerly tip of Manhattan Island, at the Battery, far into the Borough of the Bronx. With increase of population the rush-hour traffic has much exceeded the comfortable carrying capacity of these roads for many a day. Real "express" service is practicable only on portions of these lines which have three tracks, express trains being run downtown in the morning and uptown at evening. To augment the number of trains making fast time, with few stops, it was determined to add a third track on other large portions of the elevated system. Manifestly these extensive improvements must be effected with minimum risk of danger to, and least practicable interference with, traffic on both elevated structure and street surface. In the aggregate about 15 miles of third-tracking are to be done, requiring the fabrication and erection of approximately 50,000 tons of structural steel. The estimated cost of the work, including station equipment, etc., is, in round numbers, $8,000,000.

These unusual and difficult operations are to be carried out by the Manhattan Elevated Railway Company under the general supervision of the Public Service Commission. Recently it was announced that the management and engineers of the company had decided to employ three selected contracting concerns of New York City to do this work on the basis of cost plus 15 per cent. Choice fell upon the Terry & Tench Company, the Snare & Triest Company and the T. A. Gillespie Company, all of whom have well-trained organizations experienced in work of this general character. Among these three contractors the work is to be apportioned from time to time as may be found expedient. In these days when competitive bidding on contracts for public and quasi-public works is so commonly insisted upon, and the "investigator," now so numerous in the land, looks askance at any award to other than the lowest bidder, the Manhattan company's policy is an undertaking of such magnitude that it unavoidably excites interest, curiosity and criticism.

When, however, the exact nature of the proposed work is comprehended, together with its intimate relation to the operating of the elevated railways, the wisdom of the policy of intrusting it only to contractors of proven ability and resources should be patent. Furthermore, the difficulties of preparing adequate contracts and specifications for public lettings, the still greater difficulties of making safe and reasonable bids upon such contracts, and the large expense of preparing contracts and bids constitute sufficient reasons for doing the work on an accounting basis.

Only those who have been subjected to "investigation," criticism, censure and abuse for service to the public can appreciate the strength of conviction and courage needed to establish and pursue the policy outlined for operations which will be so continually and conspicuously in "the public eye." Unquestionably, efficiency and integrity of a high order will be demanded of the engineers in charge, of the contractors, of the subordinates of both, and of the management of the Manhattan Elevated Railway Company.

Vagaries in Bidding

DIVERGENCE of ideas as to the proper contract price for large work was illustrated by bids recently opened by the Board of Water Supply of the City of New York for two extremely different undertakings. On Jan. 27 twelve bids were received for laying a 36-in. flexible-joint cast-iron submarine pipe line from Brooklyn, across the Narrows of New York harbor to Staten Island, a distance of almost 2 miles. A description of this project was printed in the Engineering Record of Sept. 20, 1913, page 317. It was regarded as one of the most difficult portions of the Catskill aqueduct to construct, involving to a high degree risks due to weather, concentrated marine traffic, deep water and fairly strong currents. A few proposals with widely varying prices would be the ordinary expectation for such an undertaking, in which the losses or profits might be great, and would depend largely upon uncontrollable circumstances and chance. That so many bids were received from responsible and able contractors might well be a matter of satisfaction to the board and its engineers.

The lowest bid totaled $996,862 and the highest $1,685,940. One week later ten bids were received for furnishing a large number of valves and sluice gates, principally large-sized cast-iron gate valves of the standard Board of Water Supply patterns, of which many had been made under previous contracts. Very little unusual work was required under this contract. All the bidders were concerns experienced in work of this character. Several of them had made similar valves and gates for the board before. The lowest proposal was $88,600 and the highest $144,895. On comparing these two sets of bids it is discovered that the proportionate range is no greater for the project which might well be ranked high in the gambling class than for the other, which might equally well be considered free from large uncertainties. In each case the highest bid was about two-thirds greater than the lowest. In both cases there was a second bid very close to the lowest, and a third not far above. In both groups some of the bidders should have had the best available cost data on which to base their proposals. An even greater range of prices might not have been surprising for the submarine pipe line. The very low prices offered by some of the latter bidders suggest that it is a good time to buy valves if any communities are anticipating the use of them in large numbers in the near future.

Operation of Sewage-Treatment Works

RECENT discussion in England regarding the status of managers of sewage-treatment plants indicates that the importance of their functions is more clearly comprehended abroad than here. Doubtless the tradition in this country that any true American is, by virtue of his citizenship, and quite apart from any special ability and training, competent to do anything is responsible for placing the operation of sewage-treatment plants in the hands of amateurs or those not fitted to conduct them effectively and economically. Moreover, the layman assumes that works properly designed by a competent engineer must be practically automatic, and that very slight attention to the obvious physical needs of the plant is all that is required.

Engineers, however, know, and thinking citizens should appreciate, that the best-designed plant, perfectly adapted to its location and conditions and well constructed, must be operated with a fairly high degree of intelligence. It requires not only constant attention in cleaning screens and basins, removing sludge and other material, and maintaining mechanical equipment, but also skilled supervision by one who understands the principles of disposal works, who is able to test the results and to adjust operation to the requirements indicated by the tests.

The operator, or a laborer under his direction, must clean out the grit chambers after practically every storm and must rake the screen regularly; must remove scum and floating matter from the settling tanks and sludge from the tanks and sludge beds; dispose of the sludge after it is dry; maintain the dosing mechanism, sprinkling nozzles, etc., in good operating condition; clean the filter stone; pump the sludge from the final tanks; maintain the chlorinating devices; and perform other duties, which need not be here enumerated. None of these operations can advantageously be made entirely automatic, although the actual physical labor can be reduced to some extent.

The supervisor, on the other hand, must observe the operating results. He must make tests of the quality of the sewage at various stages in the plant, so as to determine whether or not each part is doing its duty; note the condition as to septicization of the sludge, and the clogging and unloading of sprinkling or contact filters, and see that the quantity of sterilizing medium is adjusted to the quality of the effluent. It is apparent, then, that the result—the proper condition of the effluent before discharge—involves many important intermediate duties.

It takes men of two distinct classes, therefore, properly to operate a disposal works. The operator must be an intelligent, skilled laborer, experienced in the work. The supervisor must be a specialist, grounded in the principles utilized in the plant and experienced in sewage treatment under various conditions. Both of these must be unaffected by the vicissitudes of local politics.

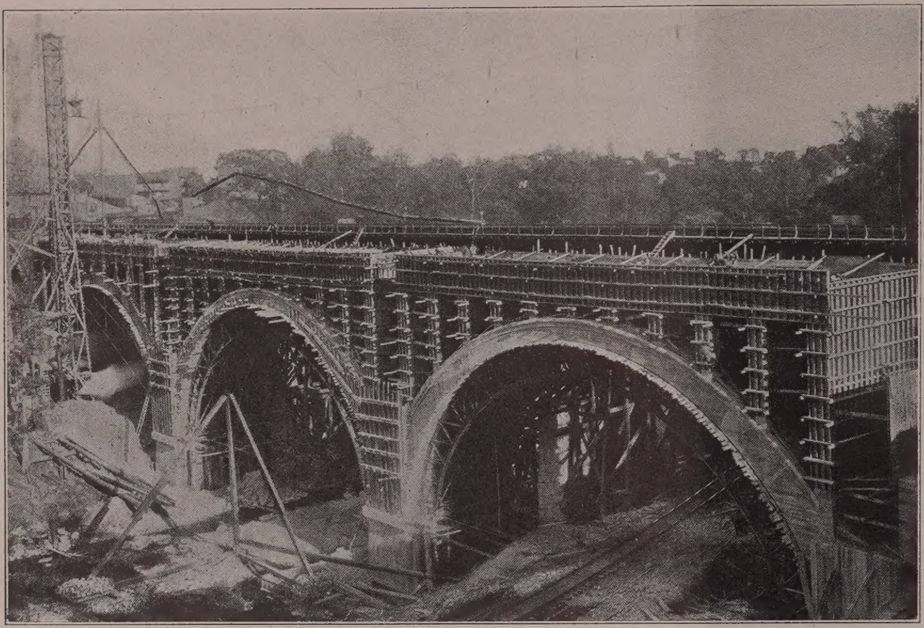
A method applied with success and widely used in water-filter installations has fortunately found favor in connection with the larger and more important sewage-treatment works. The designer of the plant is retained to act as consultant for the first few years and puts a capable assistant in charge. In this way the difficulties inevitable during the tuning-up stage are intelligently met and the best service of which the plant is capable is more rapidly obtained. An extension of this system—to apply throughout the life of the plant—is certainly well worth considering.

The cost of proper operation and supervision is, of course, a material item. The total may run from 10 cents to $1 per capita per year, and in extreme cases even higher. While this expense cannot be easily overlooked, it likewise cannot be safely omitted. The cost of municipal government will probably run in the various communities from $20 to $40 per capita per year. As a percentage of this total the maintenance cost of the sewage-disposal works is not disproportionate.

The effect of improper operation is generally experienced not by the community itself but by its neighbors. For this reason it is not uncommon to reduce operating costs and, if possible, obtain the minimum results that the State authorities or the courts will permit. While, from the selfish, mercenary viewpoint this may be good business, it surely does not savor of honesty. It should be a basic principle with each community, as well as each individual, that none of its acts should be harmful to its neighbors.

A clear duty, therefore, rests upon the city or borough engineers. They carry the burden of the design and supervision of the public works of the community, and, even when fully competent in sanitary matters, cannot, for lack of time, give the needed attention to sewage-disposal problems. It is for them to urge upon the city authorities the unappreciated fact that sewage treatment requires skilled operators and skilled supervision, and that sufficient money must be provided to maintain a standard which will not only just avoid the condemnation of State health authorities or injunction suits but will be in accord with the demands of civic honesty.

Dr. H. P. Letton, of the United States Public Health Service, in a recent paper before the New England Waterworks Association, advocated in preference to separate skilled supervision the co-operation of small communities in the establishment of a central laboratory with a competent supervisor. Such a scheme has manifest advantages. It is mentioned here only incidentally, for it is not the purpose of this journal to advocate any particular form of organization. The one essential is that skilled operation be given a place alongside of adequate and correct design, as a sine qua non of satisfactory sewage disposal.



Concrete Chuting Tower and Forms for Spandrel Walls

Building a Concrete Bridge in Halves

Four-Track Arches of 115-Foot Span Replacing Old Bridge Over Gwynns Falls in Baltimore Were Built without Interrupting Railroad Traffic

CONSTRUCTION in successive longitudinal halves was the method adopted in building the new four-track, reinforced-concrete arch bridge across Gwynns Falls, Baltimore, in order to prevent interruptions to traffic on the Philadelphia, Baltimore & Washington Railroad. The viaduct is 580 ft. long and 68 ft. wide over all on the piers. The long-span arches were supported during construction on steel truss centers. Traffic was maintained on the old double-track structure over the falls while the first half of the new bridge was built and will be transferred to the latter while the old bridge is removed and replaced on the same center line by the second half of the new structure. Concrete was mixed at a central plant and distributed over the entire work by chuting from a tall wooden tower and by a cableway, which also handled the falsework trusses.

MAIN PIERS

The bridge crosses a valley with rocky sides which afford solid foundations for the piers and abutments at a short distance below the surface of the ground and above water level, thus greatly facilitating their construction. One of the center piers in the middle of the valley has a footing about 9 ft. below the original surface of the ground and is 97 ft. below the top of the parapet. It is a solid mass of masonry up to the springing line, above which a large rectangular hollow central space is inclosed by thick vertical walls, paneled at the ends and supporting a reinforced-concrete floor slab.

The other three main piers are similar to the upper portion of the center pier, except that their footings, practically at skewback level, are unsymmetrical in order to give bearings on the rock normal to the axis and horizontal. As no two of the adjacent arches are of equal span, the piers receive correspondingly unbalanced thrusts, which in one case are applied at different elevations, and are designed of sufficient width and strength for the stresses. The piers are not reinforced below the skewbacks. Above them they are reinforced, the long walls corresponding with the regular transverse spandrel walls. The face walls, parallel to the axis of the bridge, have ¾-in. vertical rods 12 in. apart and ¾-in. horizontal rods 4 ft. apart.

ARCHES

There are three main arches having spans of 115 ft. to 75 ft., each of them consisting of a single three-centered ring 60 ft. long cast in separate voussoirs with interlocked radial construction joints. The longest span has a depth of 4 ft. at the crown and has eleven voussoirs with a maximum length of 15 ft. at the skewbacks. Both the intrados and extrados are reinforced by 1-in. curved rods in vertical planes 12 in. apart parallel to the bridge axis and by ¾-in. horizontal rods 3 ft. apart parallel to the axis of the arch. All of the rods are spaced 6 in. from the curved surfaces of the arches and overlap 4 ft. at joints.

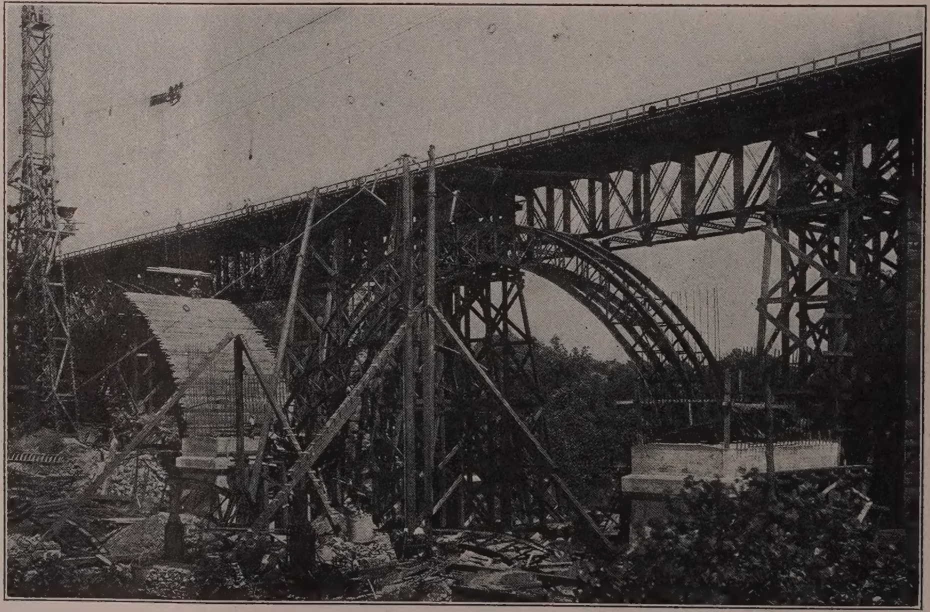
All of the arches carry solid transverse vertical spandrel walls 30 in. thick and 9 ft. apart in the clear. These walls are reinforced by horizontal rods and by vertical rods extending down into the arch ring. They support separately cast reinforced floor arches with their axes transverse to the bridge axis. These arches have a minimum thickness of 24 in. at the crown and form a continuous lower platform, which is pitched to 12-in. drainage holes at the intersections of the center lines of the arches and of the bridge axis.

Floor arches are reinforced by ¾-in. inclined rods 12 in. apart which pass through the haunches and extend from the crown to the tops of the spandrel wall, where there is a construction joint between the floor slabs and the latter. They are also reinforced by 1-in. rods 12 in. apart parallel to the bridge axis and by ¾-in. rods 24-in. apart transverse to the bridge axis, both of them located in a horizontal plane about midway between the intrados and the extrados at the crown. At both ends of the bridge the floor is carried beyond the main span by small arches supported on transverse walls like the spandrel construction of the main span.

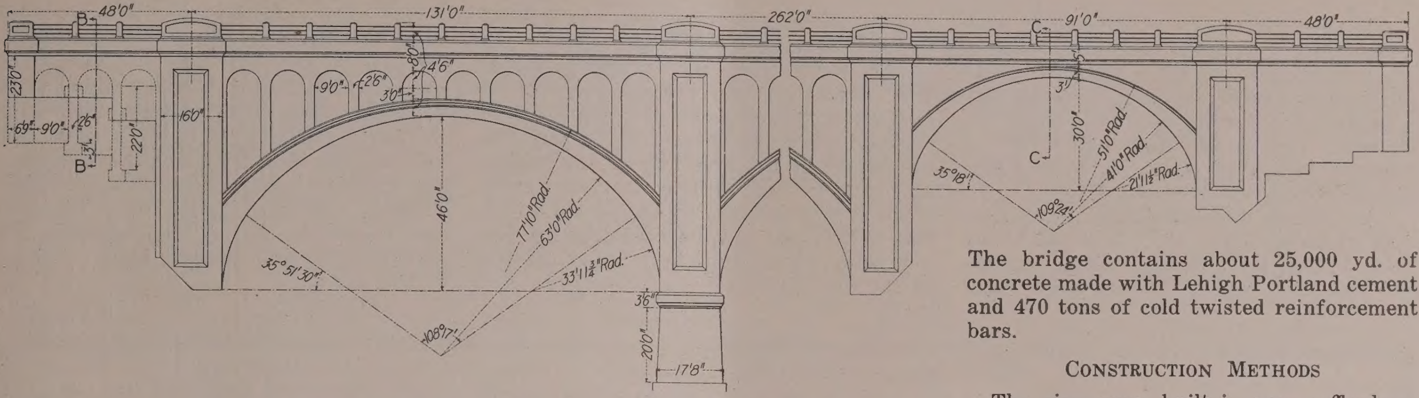
FLOOR PLATFORM

The floor platform is monolithic except for transverse construction joints, which provide for expansion on both sides of each pier and of the crown. Corresponding vertical expansion joints, L-shaped in cross-section, are made between the end and side walls of each pier. The space between the spandrel walls above the arch ring is accessible from the floor platforms through a manhole at each end of the bridge and two manholes at one of the center piers. Continuous passage from end to end of the bridge over the arch ring is provided for by narrow arch openings through the transverse walls and the pier walls.

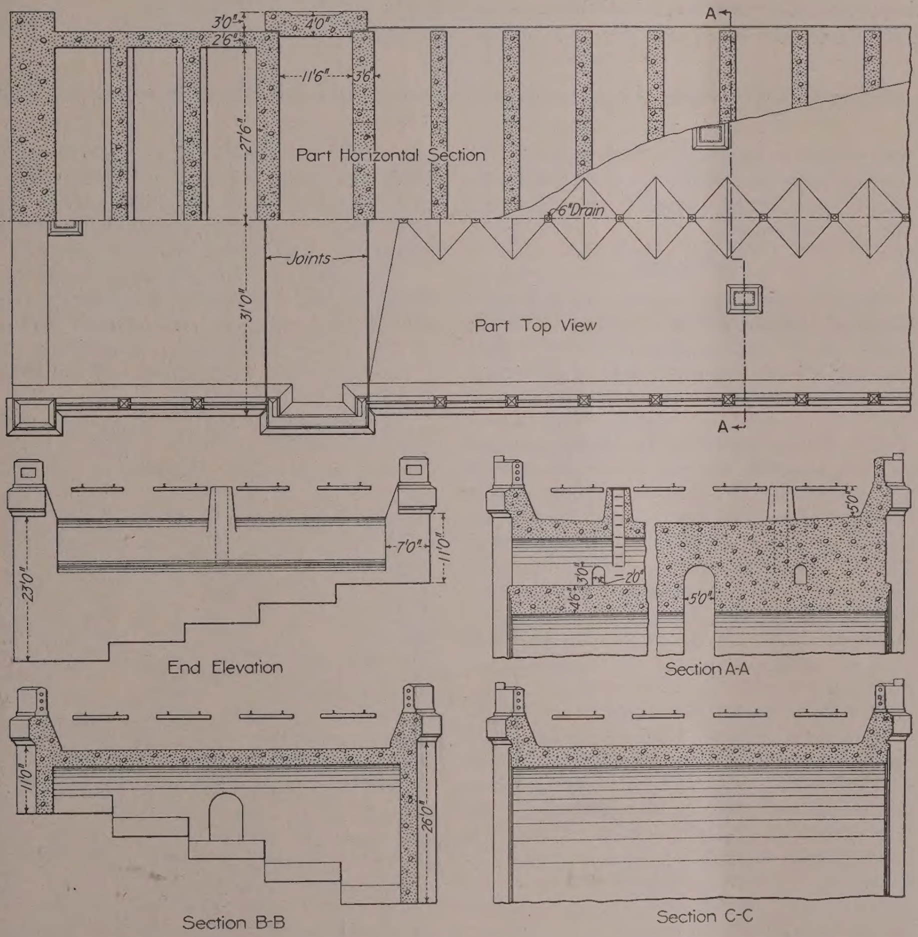
On each side of the bridge there is a solid longitudinal spandrel wall 8 ft. high above the crowns of the spandrel arches. It is molded to give a cornice effect and is surmounted by a heavy pipe rail. The four tracks are laid on a fill covering the full width of the bridge between parapet walls.



Steel Trusses for Arch Centers, Concrete Tower and Falsework Towers



Arch Rings, Types of Piers, Spandrel Walls and Parapets



Sections Showing Construction of Arch Ring, Parapet and Spandrel Walls

Forms Supported on Concrete Arch Rings, Concrete Tower and Cableway

The bridge contains about 25,000 yd. of concrete made with Lehigh Portland cement and 470 tons of cold twisted reinforcement bars.

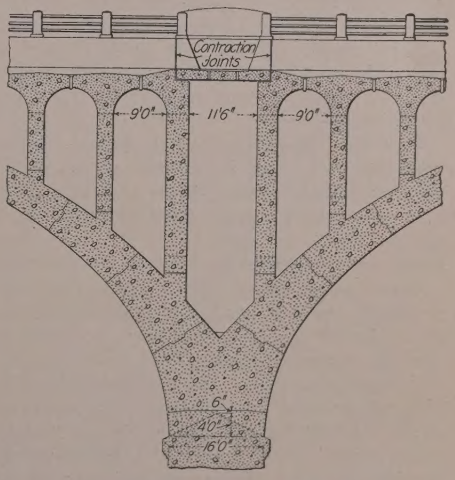
CONSTRUCTION METHODS

The piers were built in open cofferdams and are of monolithic construction up to the skewbacks, having the lower ends of reinforcement bars embedded in them and projecting above the surface of the concrete to reinforce the extrados and intrados of the arches. Although they clear the piers of the old structure, they are so near the latter that before making the excavation for the first half of the new pier, timber falsework towers were built alongside the old piers to shore the ends of the spans in service and prevent any settlement of them which might be due to the possible undermining of the old piers.

Gravel and sand were dumped from the cars through a hopper to an Allen belt conveyor, 400 ft. long, installed in a trench which delivered to a hopper-bottom storage bin of 40 yd. capacity.

The bin discharged through chutes to a Milwaukee concrete mixer, from which the concrete was elevated to the top of a tower 200 ft. high and chuted wherever required on the work.

A Flory cableway of 600 ft. span was installed on the center line of the first half of the bridge for general service in handling forms, reinforcement steel and some concrete, to remove the old bridge, and to assist the stiffleg derricks commanding the piers. With it the steel arch trusses for each set of centering were erected on the 12 x 24-in. transverse caps of bents of vertical 12 x 24-in. falsework posts and braced together to receive the 6 x 4-in. wooden lagging of alternately long and short pieces to provide projecting ends to which the faces of the forms were braced. The arch trusses were shipped riveted up in sections, and were bolted in complete trusses, with a maximum weight of 6 tons each, before erection. They were of one-hinge type, with a pin and socket joint at the crown. The centers were struck by wedges.



Section Parallel to Axis

The arch forms were subdivided by horizontal transverse radial bulkheads, enabling the arch rings to be cast in alternate blocks for voussoirs arranged so as to provide continuously for symmetrical loading of the centers. Levels carefully taken while the concrete was being poured in showed that the deflections never exceeded ⅛ in.

The concrete was deposited at a maximum rate of from 250 to 350 yd. in ten hours, each voussoir being cast in a single continuous operation, which in some cases lasted for fourteen hours. The arch was allowed to set for twenty-eight days before the centers were struck, and showed no deflection thereafter. An average force of 60 men was employed about eight months from the commencement of concreting until the completion of the first half of the bridge, on Dec. 1, 1913. The traffic was transferred to the new bridge Dec. 15, and the old bridge will be removed and the second half of the new bridge constructed in the same manner as the first half.

The work was designed and executed under the direction of the engineering department of the Pennsylvania Railroad, of which A. C. Shand is chief engineer and H. R. Leonard engineer of bridges. The Estate of Charles McDermott is the general contractor. The steel trusses for the arch centers were fabricated by the Blaw Steel Construction Company, which also furnished steel forms for part of the spandrels, the remainder of the concrete being cast in wooden forms.

Standards of Concrete Road Construction

Recommendation as to Specifications, Construction, Maintenance and Costs Offered by Committees at National Conference on Concrete Road Building, Held in Chicago February 12 to 14

COMMITTEE reports bearing on standard practice of concrete highway construction were offered at the National Conference on Concrete Road Building, held in Chicago Feb. 12 to 14. A résumé of the conclusions and advice included in these reports is given herewith.

AGGREGATES

The committee on aggregates for concrete roads consisted of Sanford E. Thompson, consulting engineer; A. N. Talbot, president of the American Society for Testing Materials, and W. M. Kinney, assistant engineer, Universal Portland Cement Company. Stress was laid on the fact that the accuracy used in preparing other road-building materials should be applied in putting together concrete to be used for that purpose. To this end there are offered specifications for aggregates which, while in the main agreeing with the standard specifications now in force, nevertheless need to be studied by those who think that the incorporation of cement, sand and stone into concrete is a simple matter.

Actual laboratory tests are insisted upon for the fine aggregates, as it is difficult to distinguish by appearance between good and poor sands. Dry grains of sand are required to pass a ¼-in. screen, while in the field a ⅜-in. mesh, or in some cases a ¼-in. mesh, may be used. At least 2 ft. of top soil and loam should be removed before using sand, to obviate the danger of the presence of vegetable loam. In no case shall sand be accepted whose strength in 1:3 mortar at the age of 72 hours is not at least 80 per cent of the strength of standard Ottawa sand mortar in the same proportion.

For the stone the usual durable types are specified, the preferred shape being cubical. Shale, slate, shells and soft limestone must be rejected. The specified limits in size are ⅛ in. and 1½ in. for one-course pavements, and ⅜ in. and 2 in. for two-course pavements. If bank gravel or crushed stone is used the sand or screenings should be separated and remixed in the proper proportions.

Letters from a large number of cities showed general satisfaction with the concrete pavement; adverse criticism usually came from cities where the specifications or description of the work indicates wrong practice. The report urged the following practice: If local conditions prevent following any one of these principal rules, adopt some other material than concrete for the pavement.

SUBGRADE

The committee on preparation and treatment of subgrade for concrete roads includes Ira O. Baker, professor of civil engineering, University of Illinois; A. R. Hirst, State highway engineer of Wisconsin, and A. N. Johnson, State highway engineer of Illinois. The report states that inasmuch as the strength of a plain concrete slab as a beam to carry a load over a low spot in the foundation is very slight, great care should be taken in preparing the subgrade. This is especially true if the concrete pavement is to be constructed upon an old roadbed, which is likely to be more compact in the center than at the sides. In this case it is not sufficient to roll the subgrade longitudinally, since the roller tends to balance upon the more compact central core.

In connection with drainage, if the soil is only moderately retentive it will probably be sufficient to lay a line of ordinary farm tile along each side of the pavement. The tile should be at least 4 or 5 in. in diameter, should be laid 2½ to 3 ft. below the surface and the drain should have sufficient fall to carry off any flow promptly. It is better to lay the tile outside of the ends of the slab than under it.

For soil more readily saturated it is recommended that a shallow longitudinal ditch be constructed just outside the edge of the slab, extending about 8 or 10 in. below the surface of the roadbed, and that this ditch be filled with coarse gravel or broken stone. Short transverse ditches should be dug across the road to the side ditch. In particularly retentive soil these transverse ditches should be placed not more than 50 ft. apart.

A set of specifications for subgrade are included, covering clearing and grubbing, excavating and embanking, and rolling the roadbed.

MAINTENANCE METHODS AND COSTS

The committee on method and cost of repairing and maintaining concrete roads was composed of Edward N. Hines, J. S. McCullough and F. P. Wilson. The contribution of Mr. Hines, who is chairman of the board of county-road commissioners of Wayne County, Michigan, is here given practically in full. His opportunity to study the many miles of concrete roads in that district, some of which are in their fifth year of service, lends value to his remarks. Mr. Hines' remarks follow:

"Our work in Wayne County consists in filling the open expansion joint on the roads first built before the development and use of the armor joint, and in the filling with a mastic such longitudinal and transverse cracks as have developed.

"A crew consisting of seven men and a team, provided with a tar kettle, is utilized for the work. The foreman is paid $5 a day, the team and driver $5, the "tar man" $3, two laborers $2.50 each and two others $2.25 each. The tools used consist of two wire bristle brooms, a wheelbarrow, a couple of shovels and a tar bucket with a round spout. Tarvia X is now used exclusively. A lighter grade was first tried out, but did not give such permanent results as the heavier grade. Two men are utilized to sweep all cracks clean with the wire brooms, after which the man with the tar kettle fills the cracks with the tar, which is heated to about 225 deg. Fahr. An excess of tar is poured in so that it extends an inch or so beyond the edge of the crack. It is then allowed to stand in the crack for a few minutes to prevent it from "bubbling" out in case the sand is wet. The sand, which should be dry and coarse, is spread with a shovel over the crack and into the tar, and the whole is left for traffic to iron out. The excess tar and sand is worn away rapidly, leaving a smooth, even surface, in passing over which no jolt is apparent. This method of repair prevents the edges of the concrete from spalling and chipping, and no water can get through to the subgrade to freeze and heave in cold weather.

"The work is preferably done on hot, dry days. It has been suggested that the better time to handle this work would be in the late fall when the cracks would be open the widest due to contraction, but the results we have secured in the summer months have been so satisfactory that we have not tried out the latter plan. The small pit holes which are due simply to some foreign substance like clay, wood or some fragment of inferior rock which might chance to be a part of the aggregate, are treated in the same manner. As to the cost of this method, I desire to present a verbatim report of the members of the engineering staff, George A. Dingman and George F. Key:

COST OF REPAIRS TO WAYNE COUNTY ROADS FROM OCT. 1, 1912, TO OCT. 1, 1913

		Michigan Avenue, 17 Miles			
Tar	20	bbl.	at $6.00	$120.00	
Labor	10	days	at 22.50	225.00	
Sand	18	yd.	at 2.00	36.00	$381.00
		Grand River, 10 Miles			
Tar	14	bbl.	at 6.00	84.00	
Labor	6	days	at 22.50	135.00	
Sand	8	yd.	at 2.00	16.00	235.00
		Gratiot, 1½ Miles			
Tar	3	bbl.	at 6.00	18.00	
Labor	2	days	at 22.50	45.00	
Sand	4	yd.	at 2.00	8.00	71.00
		Jefferson, 1¾ Miles			
Tar	6	bbl.	at 6.00	36.00	
Labor	2	days	at 22.50	45.00	
Sand	4	yd.	at 2.00	8.00	89.00
		Van Dyke, 2 1/3 Miles			
Tar	5	bbl.	at 6.00	30.00	
Labor	1½	days	at 22.50	33.75	
Sand	4	yd.	at 2.00	8.00	83.00*
		Mount Elliott, 1½ Miles			
Tar	3	bbl.	at 6.00	18.00	
Labor	1½	days	at 22.50	33.75	
Sand	4½	yd.	at 2.00	9.00	60.75
		River, 7 Miles			
Tar	10	bbl.	at 6.00	60.00	
Labor	5	days	at 22.50	112.50	
Sand	12	yd.	at 2.00	24.00	196.50
		Eureka, 4¼ Miles			
Tar	4	bbl.	at 6.00	24.00	
Labor	2	days	at 22.50	45.00	
Sand	4	yd.	at 2.00	8.00	77.00
		Wayne Road South, ½ Mile			
Tar	1	bbl.	at 6.00	6.00	
Labor	½	day	at 22.50	11.25	
Sand	1½	yd.	at 2.00	3.00	20.25
		Woodward Avenue, 2¼ Miles			
Tar	5	bbl.	at 6.00	30.00	
Labor	2	days	at 22.50	45.00	
Sand	6	yd.	at 2.00	12.00	87.00
51 miles*, total......................					$1,300.50

*The arithmetical discrepancy is a part of the report.—EDITOR.

"A percentage was added to cover engineers, inspectors and the depreciation of machinery and building and other "overhead" charges, making the total about $1,450. The greater part of this mileage was treated for the first time. Once a year is often enough to go over the work and touch it up here and there, as we have found by experience that the bulk of the repairs previously made is intact.

"We have not had as good success in treating the entire surface of a road where the concrete from any cause has not stood the wear. One-half mile of concrete on Fort Road, built by Porath & Son, about 800 ft. on Grand River Road, built by the Owosso Construction Company, and 1¾ miles on Gratiot Road, out of the 80 odd miles of concrete road in Wayne County, are not up to the standard of the balance of the construction, and they have been surfaced with Dolarway, a special grade of Tarvia and Tarvia X. The surfaces of Fort and Gratiot Roads were both rough, having been built in cold weather, and opened for traffic before the concrete had thoroughly hardened. Fort Road was surfaced by the contractor before the board would accept the road and make the final payment. It carries a fairly heavy mixed traffic, not as great, however, as either Grand River or Gratiot Roads. A special grade of Tarvia was used, furnished by the Barrett Manufacturing Company. The road was first swept by a street sweeper, which was followed by men with wire brooms. About ½ gal. of bitumen to the square yard was used, and the whole covered with coarse sand and rolled with a 10-ton roller. This repair was made early in the summer and was not touched in any manner for a period of two years. By this time it had scaled off in spots quite badly, and was gone over again in the summer of 1913, using Tarvia X and a washed roofing gravel about ¼ in. in size. We have no record of what the first cost was to the contractor, as we paid nothing for it.

"Gratiot Road was surfaced at cost to us by the Dolarway people in the spring of 1912. By the summer of 1913 about half of the original coating had scaled off, at which time we patched it up, using a special grade of Tarvia and Tarvia X. The Tarvia X has given the better result to date. Washed roofing gravel was used with the bitumen. This work was also rolled with a 10-ton roller. Gratiot Road carries an average traffic of over 1,000 vehicles a day. (On the last count made one week in August and one week in September the average was 1210, of which 36 per cent was motor traffic and 64 per cent horse-drawn vehicles.) The surface of the road is wavy, and we have found it necessary to go over the work two or three times during the summer, touching up small spots here and there where it had scaled off. The cost of the work done by our board is in the neighborhood of 9 cents per square yard."

SHOULDERS

The report on shoulders for concrete roads was submitted by Maj. W. W. Crosby, consulting engineer; E. A. Kingsley, former State highway engineer of Arkansas, and John H. Mullen, secretary of the Minnesota Roadmakers' Association. This report digresses somewhat in stating that a real economy would be obtained by increasing the widths of the road crusts so that nowhere would they be less than 18 ft. This would involve making the concrete itself wide enough to permit the passing of two lines of traffic without causing either to pass off the concrete on to the shoulder. Of course, for certain conditions the greatest economy would be found if the concrete surface was only made wide enough for one line of traffic.

In any event there should be used at the junction of the shoulder and the concrete roadway itself some material more durable than the natural earth. What material is chosen would be determined by such local conditions as the availability of material, the width of the road crust and the amount of traffic, but the wearing ability of the shoulder material should be above that required for the stresses to be expected at any point. A similar recommendation in the recent report to the American Society of Civil Engineers of the committee on bituminous materials for road construction was endorsed.

The report on mixing and placing materials for concrete roads was submitted by Paul D. Sargent, chief engineer of the State highway commission of Maine; Arthur H. Blanchard, professor of highway engineering at Columbia University, and C. W. Boynton, inspecting engineer of the Universal Portland Cement Company. An abstract follows:

In charging the skip a part or all of the coarse aggregate should be placed first, and the cement, fine aggregate, and remaining coarse aggregate, if any, on top of this. All the cement should be in the skip before the last of the aggregate is added. If charged in this manner there will be less tendency for the materials to stick in the skip when emptying and less loss of cement on windy days. A systematic method of loading the skip will also serve as a check on the right amount of material being placed each time.

TABLE 1—MIXING DATA OBSERVED IN PRACTICE

Mixer	R.p.m.	Mixing time
Smith	10	1½ min.
Koehring	18	40 to 45 sec.
(Unknown)	18	30 sec.
Foote	14	45 sec.
Eclipse	13	2 min.
Austin cube	16	50 to 55 sec.
Smith	11	2 min.
Chicago	24	30 sec.
Foote	18	25 sec.
Koehring	18	20 sec.
Austin cube	16	20 to 60 sec.
Koehring	32	15 sec.
Austin cube	16	10 sec.
Ransome	7	1 min.
Koehring	18	20 sec.

No important operation is given less attention than the mixing of the concrete. Frequently the time the materials remain in the drum is governed only by the speed of the gang charging the skip. At times the batch mixer is operated practically as a continuous mixer, by fastening the discharge scoop or spout so that there is a constant flow of concrete from the mixer.

To insure thorough mixing the r.p.m. of the mixer and the time the complete batch, including water, remains in the mixer, should be specified. To specify only one is not sufficient, as shown by Table 1.

TABLE 2—CAPACITY AND SPEED OF PAVING MIXERS

Name of mixer	Rated capacity, cu. ft. unmixed material	Capacity bags of cement in 1:2:3 mix	R.p.m. of drum	Name of manufacturing company
Austin cube	22	3	18	Municipal Engineering & Contracting Company.
	14	2	18	
Chicago mixer	10	1	15	Chicago Concrete Machinery Company, which is the T. L. Smith Company.
	14	2	12	
	23	3	11	
	30	5	10	
Smith mixer	14	2	14	
	24	4	12	
	33	5	11	
Foote mixer	7	1	18	Foote Concrete Machinery Company.
	13	2	16	
	23	3	14	
Koehring	7	1	20	Koehring Machine Company.
	12	2	17	
	20	3	16	
	24	4	15	
	30	5	15	
Oshkosh	18	3	18–20	Oshkosh Manufacturing Company.
Milwaukee	8	1	20	Milwaukee Concrete Mixer Company.
	14	2	18	
	20	3	18	
Ransome	8	1	21	Ransome Concrete Machinery Company.
	10	1	21	
	18	3	20	
	21	3	20	
	24	4	17	
	28	4	17	
Standard	7	1	16	Standard Scale & Supply Company.
	15	2	14	
	21	3	14	
	30	5	13	
Chain belt	10	1	20	Chain Belt Company.
	15	2	18	

Upon inquiry of the manufacturers it was found that the drum r.p.m. varies for different makes and for different sizes of the same make, as shown by Table 2.

Because of the shape and arrangement of the interior of the drum, the rate at which a given mixer is operated has a direct bearing upon the quality of the concrete; the drum should therefore be operated at approximately the speed at which the manufacturer claims the best results would be obtained.

All the materials in any one batch—including the water—should remain in the drum of the mixer at least 45 seconds before any of the concrete is discharged, and the drum should be completely emptied before the next skip of materials is dumped into the mixer.

The practice on road work is to mix concrete entirely too wet. This causes a separation of the coarse materials from the mortar, resulting in stony pockets throughout the concrete. Where the concrete is mixed too wet, it is practically impossible to obtain and hold the required crown, and stony patches frequently appear on the surface after it has been finished, owing to the flow of water and mortar to the sides. In striking off and floating concrete mixed with an excess of water, it is also practically impossible to obtain a surface of the desired character, as the excess of water collects in and hides depressions and other inequalities in the surface, which cannot be corrected as they are not apparent until after the water has evaporated. The marked effect in the strength of concrete that a variation in the consistency produces is shown in the following table of results of tests made in the Sheffield Scientific School of Yale University by Charles J. Robinson. (See "Engineering News," Vol. 69, No. 21, May 22, 1913.)

TABLE 3—VARIATION IN STRENGTH OF CONCRETE

Per cent of water	Length of test 7 days†	 30 days*	 60 days†
20	2052	2777	3194
22½	2173	3132	3305
25	2277	3278	3388
27½	2500	3516	3597
30	1722	2874	3166
32½	1413	2416	2666
35	1222	1977	2388
37½	1097	1819	2173
42½	652	1500	1888

*Average of two tests. †One test only.

In this test as a minimum enough water was taken to moisten the stone and sand, and then there was added 20 per cent (of the amount of the cement by weight) of water. Each subsequent mixture was increased by 2½ per cent of water. It was noted that the 42½ per cent mixture was about as wet as is used in the average wet mixture, though drier than some slushy mixes.

Just before placing concrete the subgrade should be well sprinkled so that it will not absorb moisture from the concrete and should be checked by the engineer or inspector to make sure that the required thickness of concrete can be placed. Checking the subgrade may be done by the use of a straight edge or line, resting on, or stretched from the top of the side forms.

The excess of coarse material that accumulates in front of the strike-board should be uniformly distributed over the surface of the pavement, not left in narrow strips across the section or placed along transverse expansion joints. An ordinary garden rake will be found useful in distributing the material that accumulates in front of the strike-board. When the strike-board is within 2 ft. of an expansion joint the excess material that has accumulated in front of it should be removed with a shovel and deposited on the sub-grade in the next section. Special care should be taken to place good dense concrete along expansion joints, and all inequalities at the joints, including any small holes left after the removal of the installing device, should be filled with a mortar composed of one part cement and not more than two parts fine aggregate.

The strike-board should be cut to conform to the crown of the finished surface of the pavement and should be of sufficient strength and stiffness to show no deflection at the center when supported at the ends, nor a material bowing out of alignment when in use. It should be about 2 ft. longer than the width of the road, protected on the bottom edge with a metal facing and provided at each end with suitable handles.

For roads up to 12 ft. in width 2 x 6-in. planks, dressed on one side and both edges, spiked together, make a good strike-board, and for roads 12 to 20 ft. in width two 3 x 8-in.—or a 2 x 10 and a 3 x 10—spiked together, will be found satisfactory. The strike-board should not be so heavy that it cannot be easily handled by two men, and to reduce weight and increase stiffness, it is advisable for work over 20 ft. in width to use a strike-board composed of boards 2 or 3 in. thick, stiffened by trussing, rather than obtain the required stiffness by the use of heavier timbers.

COST DATA

The committee on cost of constructing concrete roads included A. N. Johnson, State highway engineer of Illinois; Joseph Hyde Pratt, State engineer of North Carolina, and Albert Reichmann, president of the Western Society of Engineers.

Valuable work was performed by this committee in averaging the cost of work reported in the different States, confining the comparison to the one-course road. These data are presented in the table at the top of the third column of this page.

The report also included diagrams showing the distribution of cost data on concrete roads recently built in various localities. The average distribution for seven Michigan roads built during 1909-1912 was as follows: Labor, 43 per cent; material, 57 per cent. Material was subdivided as follows: Aggregate, 29 per cent; cement, 22.7 per cent; miscellaneous supplies, 5.3 percent. The average cost per square yard, excluding excavation, was $1.62.

The corresponding distribution for Illinois construction in 1913 shows a charge of 38.5 per cent against labor and 61.5 per cent against material. Labor was subdivided as follows: Unloading and hauling, 13.1 per cent; mixing and placing, 11.6 per cent; superintendence and miscellaneous labor, 7 per cent; shaping roadbed and trimming shoulders, 6.8 per cent. Materials was also subdivided, as follows: Cement, 31.7 per cent; aggregate, 25.2 per cent; expansion joints and miscellaneous, 4.6 per cent. The average cost per square yard, excluding excavation was 94.3 cents.

The cost data on eight sections of road in Wayne County, Michigan, constructed during 1912 and 1913 were as follows: Labor, 46 per cent, and materials, 54 per cent, divided as follows—cement, 19.9 per cent; aggregate, 27 per cent, and miscellaneous, 7.1 per cent. The average cost per square yard is not reported.

AVERAGE COST OF ONE-COURSE CONCRETE ROADS

State	Cost per square yard
Arizona	$1.20
Arkansas	.90
California	1.17
Colorado	1.25
Connecticut	1.32
Delaware	1.61
Idaho	1.09
Illinois	1.01
Indiana	1.23
Iowa	1.11
Kansas	1.08
Maine	1.48
Maryland	1.21
Massachusetts	1.29
Michigan	1.27
Minnesota	1.05
Missouri	1.17
Montana	1.83
Nebraska	1.40
New Jersey	1.12
North Dakota	1.26
Ohio	1.22
Oklahoma	1.05
Oregon	1.39
Pennsylvania	1.16
Tennessee	1.20
Washington	1.31
West Virginia	1.32
Wisconsin	1.06
Average total	$1.24
Weighted total average	$1.19

It will be seen that the average distribution for labor and materials is about that reported in the last example.

World's Concrete Placing Record

Comparative Data on Yardage for Kensico, Arrowrock and Lake Spaulding Dams

THE world's record for rapid placing of concrete and cyclopean masonry was broken last year on the Kensico dam of the Catskill Aqueduct. On other works large volumes of masonry also have been placed, and the following figures have been compiled to afford a comparison of the records on the Arrowrock dam of the Boise irrigation project in Idaho, built by the U. S. Reclamation Service (see Engineering Record Feb. 22, 1913, page 214; Aug. 2, 1913, page 116, and Sept. 6, 1913, page 265); the Lake Spaulding dam of the Pacific Gas & Electric Company, California, constructed by the company's forces (described in the Engineering Record of Aug. 9, 1913, page 150), and the Kensico dam of the Catskill Aqueduct built by H. S. Kerbaugh, Inc., and described in the Engineering Record of Dec. 25, 1909, page 728; Feb. 24, 1912, page 216; May 10, 1913, page 528, and Jan. 10, 1914, page 34. Data on the placing of concrete in these three dams are given in the following table:

RECORD OF PLACING MASONRY IN LARGE GRAVITY DAMS DURING 1913

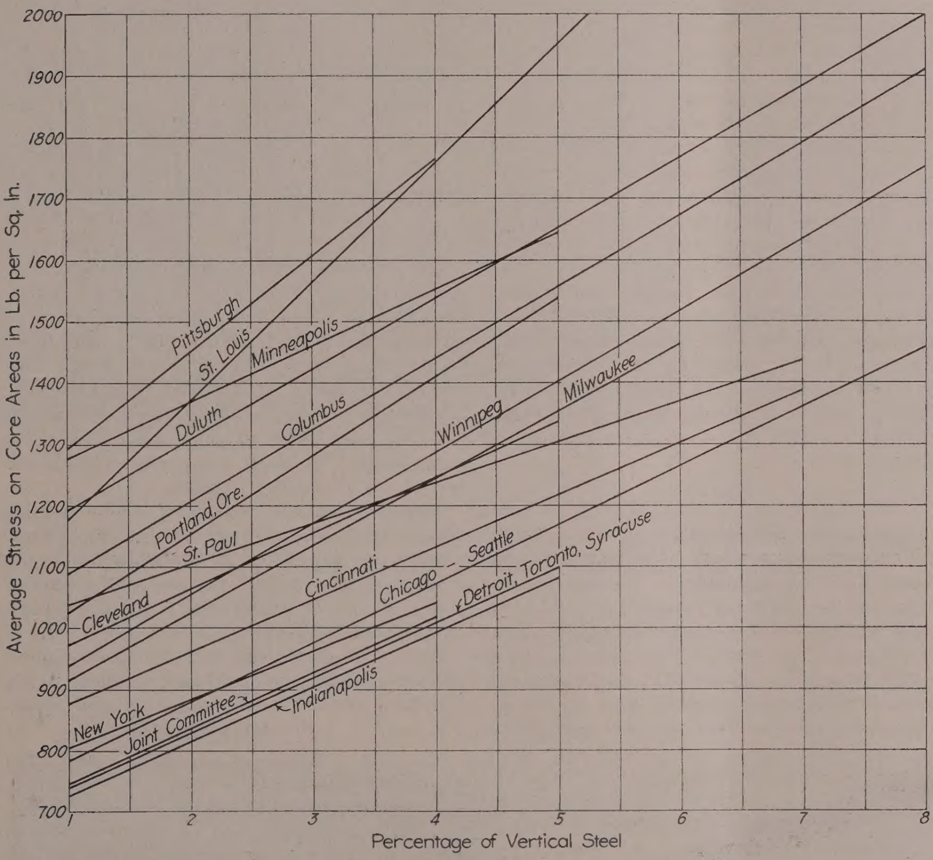
	Arrowrock Aug.	Spaulding Aug.	Kensico Sept.
Total masonry placed in dam during month, cu. yd.	38,456	40,485	53,240
Total masonry placed in dam during year, cu. yd.	......	......	316,090
Number of working days during month	26	31	25
Number of hours in average working day	8	10	8
Average number of 2-yd. "mixer hours" per day	32	*43	36
Average quantity of masonry placed per day, cu. yd.	1,480	1,306	2,130
Average quantity of masonry placed per hour, cu. yd.	185	131	266
Average quantity placed in form of blocks per day, cu. yd.	......	......	106
Average quantity placed in form of pudding stone per day, cu. yd.	......	86	514
Average quantity run through mixers per day, cu. yd.	1,480	1,220	1,510
Average output per mixer-hour per month, cu. yd.	46.3	28.4	42.0
Best day's run, cu. yd.	1,600	2,015	2,280
Average output per mixer-hour for best day, cu. yd.	47.5	50.3	54.6

*This number is 43 instead of 40, because of a little overtime.

Stress and Strength of Spirally Hooped Concrete Columns

Variation of Allowable Loads Permitted by Building Codes of Different Cities

INCONSISTENCY in various building codes with reference to the allowable unit stresses and relative strength of spirally hooped concrete columns is shown graphically in the diagram reproduced herewith from a discussion by T. L. Condron at a recent meeting of the Western Society of Engineers. Ernest McCullough had led a symposium with a paper containing ten questions concerning column design.



Stresses in Spirally Hooped Columns Permitted by Various Cities

Code requirements of twenty cities and of the Joint Committee are indicated for 1-per-cent spiral hooping and 1:2:4 concrete. In the case of Baltimore and Philadelphia the unit stresses are given without fixing the percentages of vertical steel. The Joint Committee is in substantial agreement with New York, Chicago, Seattle, Detroit, Toronto, Syracuse and Indianapolis, except that it limits the percentage of vertical reinforcement to 4 per cent. It is Mr. Condron's practice to follow the Chicago code, making the maximum limit of vertical reinforcement 5 per cent.

ORDINANCE REQUIREMENTS

A column designed with 1 per cent hooping and 4 per cent vertical steel under the requirements of the St. Louis or Pittsburgh code for a given load would be rated only for 56 per cent of that load in Indianapolis or Philadelphia, while, on the other hand, a column designed for a given load would be accepted in St. Louis or Pittsburgh for nearly double that load.

This is not a case, said Mr. Condron, where the average of various formulæ is probably the correct one, for the data available would indicate that the lower and almost the lowest of these ordinance requirements are correct, and, therefore, that the higher permissible unit stresses are not justified by present knowledge of the strength of hooped columns. When it is borne in mind that some commercial designers use column formulæ quite as radical as the highest given on this diagram, it will be seen that there is good reason to call a halt on the reckless designing of reinforced-concrete columns.

Mr. Condron agreed with Mr. McCullough that there is no justification for the use of concrete columns reinforced simply with four vertical rods and a few separated hoops or bands. Certainly such columns are dangerous to use, and it is surprising that so many of them have been used with so few disastrous results. The fact is that columns in buildings seldom receive the full load they are presumably designed for, but there is no part of a building that should be more conservatively designed than the supporting columns.

The accompanying table shows the allowable loads on the same column under different building codes. The table is for a 1:2:4 concrete column with 20-in. diameter core, 1 per cent. hooping and 4 per cent. vertical steel:

ALLOWABLE LOADS ON COLUMNS

	Tons
Indianapolis, Philadelphia	157
Detroit, Toronto, Syracuse	159
Joint Committee	160
New York	164
Chicago, Seattle	169
Baltimore	189
Cleveland, Milwaukee	196
Portland, Oregon	222
Columbus, Ohio	226
Minneapolis	236
St. Louis	276
Pittsburgh	276

LUMBER PRODUCTION in New York State amounts to about 525,000,000 ft. b.m. per year, which averages 200 ft. b.m. per acre per year. The annual consumption is nearly three times the production.

Ohio Conservancy Law

Provision for Forming and Administering Districts to Carry Out Works for Flood Prevention, Drainage or Irrigation

"TO prevent floods, to protect cities, villages, farms and highways from inundation, and to authorize the organization of drainage and conservation districts"—these are the purposes of the Ohio Conservancy Law passed Feb. 6, 1914, and commented upon in an editorial in the Engineering Record of Feb. 7. The full text of the law occupies fifty-one pages. The principal provisions are abstracted as follows:

Preliminary to the formation of a conservancy district for flood prevention, stream regulation or diversion, reclamation or irrigation, a petition signed by 500 freeholders, or by a majority in number or property ownership in the proposed district, must be filed with the court of common pleas in the county or one of the counties in which the district would lie. A public hearing by the court, or by one common-pleas judge in each county affected, must be advertised and subsequently held, and if the court rules favorably the district is thereby created as a political subdivision, with all the powers of a corporation. Within thirty days after the favorable decree the court shall appoint three directors, for respective terms of three, five and seven years, all subsequent terms being five years.

The board of directors is empowered to employ a chief engineer, an attorney and such other assistants as are deemed necessary. A plan covering the improvements for which the district was created must be prepared at once, after which a duly advertised hearing must be held, and the plan adopted as the "official plan" of the district. Objection may be made by any person or persons within ten days of the adoption of the official plan, in which case the court will hold a hearing and determine whether to approve the plan or refer it back to the board of directors.

The general powers of the board cover practically everything in connection with the quoted purposes of the Conservancy Law, including authority to alter or fill streams, construct canals, dams and reservoirs, alter bridges, roadways or streets, construct improvements through or across highways, canals or railroads and remove or change such works. The board may condemn property under the general law and may prescribe the manner of building bridges, roads or fences along any of its works.

Section 23, cited in the aforementioned editorial, authorizes the board to co-operate with the U. S. Government or with any other public or private agency in prosecuting the work, and to make necessary arrangements for outlets or other works in adjoining States. Section 24 confines the rights of users of the water of the district to such rights as were held by them prior to the organization of the district, and gives to the district the disposal of any greater, better, or more convenient use of such water. The board may not, however, make any assignment, lease or other disposition of water rights extending over a greater period than fourteen years.

Three appraisers, freeholders in the State, are to be appointed by the court for the district. Their duties shall be to appraise the lands or other property to be acquired within and without the district and all benefits and damages accruing by reason of the execution of the official plan.

A full report, known as the "conservancy appraisal record," shall be made by the board of appraisers, after which a duly advertised hearing shall be held by the court. Appeals from the court's decree may be made by interested parties, who may have the matter tried by jury.

Changes in the official plan may be made by the board of directors, subject to the approval of the court, but if the changes in the judgment of the court materially modify the general character of the work, or the damages or benefits, or if they increase the cost more than 10 per cent., the court shall order a new appraisal of the proposed changes. Such auxiliary appraisal shall be subject to the same procedure as the original report.

There shall be three separate funds for the districts—the preliminary fund, the bond fund and the maintenance fund. Expenses incurred prior to the organization of the district shall be paid for out of the general funds of the county in which the petition is pending and repaid from the first money raised by the district. As soon as the district is organized the board of directors may levy a level tax, not to exceed three-tenths of a mill, to meet expenses up to the time money is raised by the sale of bonds or otherwise. Money may be borrowed at not more than 6 per cent interest.

After the appraisal is completed the board may assess such portion of the benefits as may be necessary to pay the cost of the execution of the official plan. The assessment on each piece of property shall be proportional to the appraised benefit, but shall not exceed it. Bonds not to exceed 90 per cent of the total amount of the assessments may be issued at rates not to exceed 6 per cent, maturing at annual intervals within thirty years, commencing not later than five years from date of issue. Bonds bearing less than 6 per cent may be sold at less than par, but the price must be such that the interest on the purchaser's investment will be not more than 6 per cent.

Maintenance assessments proportional to the benefits—but not exceeding 1 per cent thereof in any year, unless authorized by the court—shall be levied annually. A hearing relative to readjustment of the maintenance assessments shall be held whenever the owners of 25 per cent of the acreage or land value shall petition for it, but in such a readjustment the appraisals shall not be limited to the aggregate amount of any previous appraisal; the 1 per cent limit shall still apply, however. The regular county officers shall collect these assessments and turn them over to the treasurer of the district.

A piece of land may be in more than one district. In case of a district being organized within, or partly within, another district, one common-pleas judge of each county affected shall confer as to what extent the districts shall be consolidated or their boundaries adjusted. Section 61, mentioned in the editorial to which reference has been made, provides that if the directors of one of two or more districts believe the districts should be consolidated they may petition the court for such a consolidation. The customary public notice of a hearing shall be given, and after the hearing the court shall, if it sees fit, order that the districts, or any of them, be united, shall designate the corporate name of such district and shall select the directors. Instead of organizing a new district the court may direct that one or more of the districts be included in another district. Subdistricts may also be created by the usual procedure of petition, public notice and hearing. The officers of the district will retain jurisdiction over the subdistricts.

The board of directors shall have the right to police the works of the district, and in times of great emergency may compel assistance by the public in the protection of such works.

Districts may be formed for irrigation, but no such district shall in its construction or operation interfere with works for the prevention of floods or the drainage of lands, or materially diminish their protective value.

Building Collapses at South Bend, Indiana

Removal of Brick Wall and Substitution of Girders and Columns Produced Concentrated Loads That Overstressed Supports

A LATELY remodeled three and four-story brick building collapsed at South Bend, Ind., at 4:10 p. m. Jan. 3. The collapse was caused by overloading the supports, as the remodeling had changed the loads from uniformly distributed to concentrated. The accident was briefly described in the Current News section of the Engineering Record of Jan. 17, page 32. Through the courtesy of William Moore, city engineer of South Bend, there follows an abstract of the report to the Mayor by an investigating committee of eight members.

The structure was located on South Michigan Street and was composed of two buildings, one on the north side, three stories high, the other on the south side four stories high. Both buildings were of brick. The total width of the structure, north and south, was 46 ft., and its length 77 ft. 4 in.

WALLS

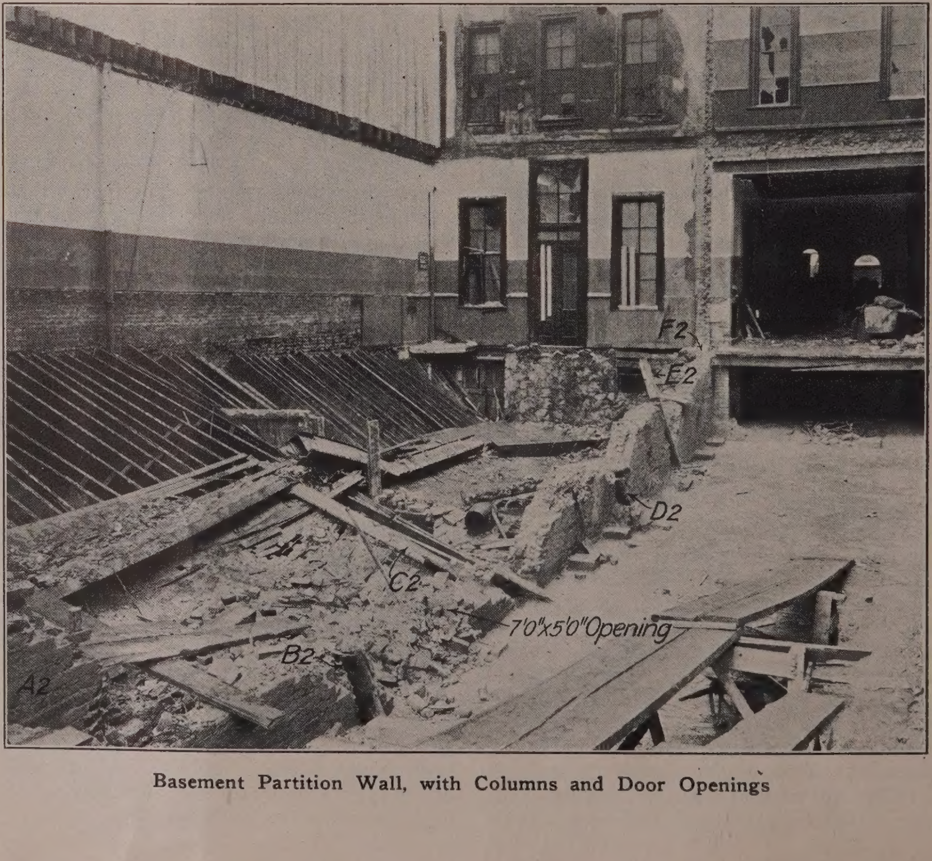
Between the buildings there was a brick wall extending the entire height of the four stories and the basement. It was 17 in. thick in the basement and 13 in. thick above ground. This wall was solid, with the exception of a few small windows in the fourth floor. The north wall had the same dimensions except for 29 ft. near the front wall, where the stairway was located. That portion was 8 in. thick and extended up to the second story. From that level up to the roof there was a studding partition with lath and plaster on both sides. The south wall was also 17 and 13 in. thick, like the others, but its thickness was 9 in. in the fourth story. The front 28 ft. of this wall were 13 in. in the basement and 9 in. from that level up. The rear wall is approximately 13 in. thick, and it is still standing, except the fourth story of the south half.

FLOORS

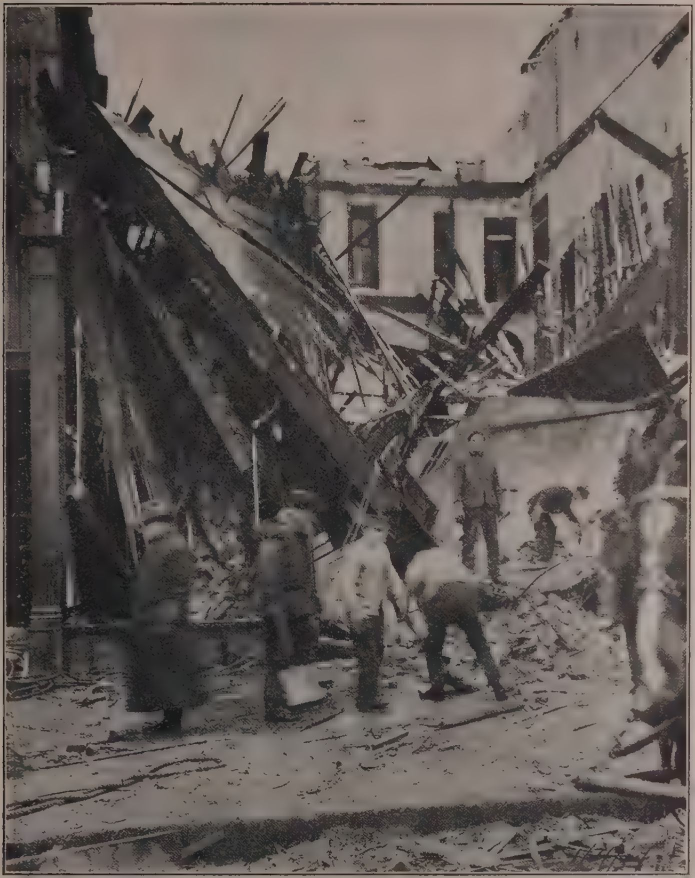
Cement was used in the basement for the south half of the collapsed building. The first floor had 2 x 12-in. joists, spaced 14 in. on centers, covered with 1 x 6-in. ash floor lining and a ⅞-in. finished maple floor. The ceiling consisted of ⅞ x 5-in. coved poplar. The joists had been cut off at the walls and lowered and were supported on 6 x 6-in. posts and 6 x 8-in. timbers. The posts rested on concrete footings.

For the second floor 2 x 12-in. joists, spaced 12 in. on centers, were used. These joists were supported in the walls and were covered with 1 x 6-in. dressed and matched poplar floor and ceiled with 1 x 6-in. dressed and matched ceiling.

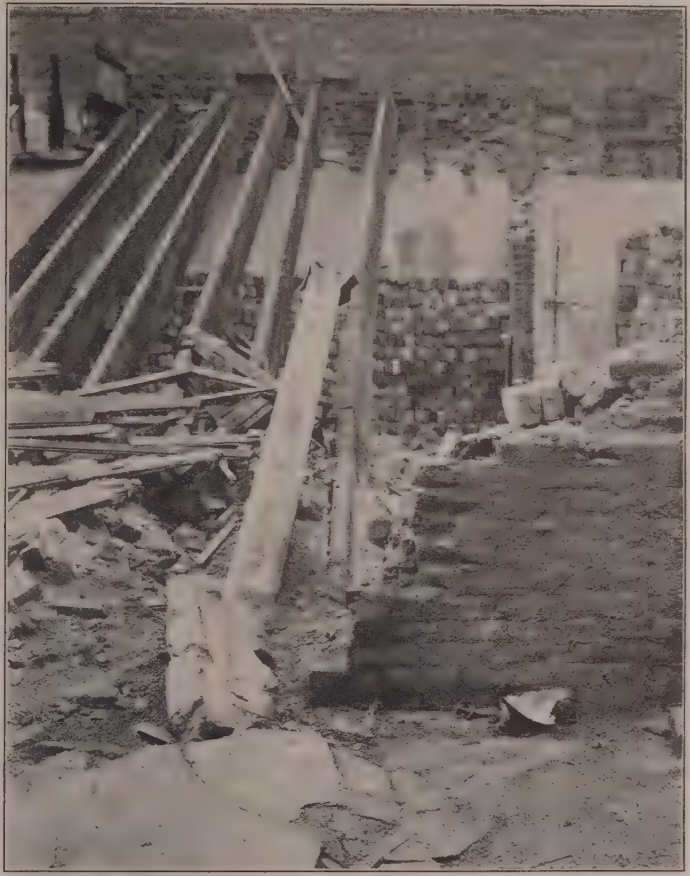
The third floor also had 2 x 12-in. joists spaced 16 in. on centers, covered with 1 x 6-in. dressed and matched poplar flooring with a lath and plaster ceiling. The



Basement Partition Wall, with Columns and Door Openings



Appearance of Building Shortly after Accident



Damage to Brick Wall at Column C_2

fourth floor had 2 x 12-in. joists spaced 16 in. on centers and matched poplar flooring; lath and plaster were used for ceiling. The fourth-story ceiling had 2 x 10-in. joists spaced 16 in. on centers covered with lath and plaster. Above this were 2 x 4-in. rafters spaced 16 in. on centers and covered with 1-in. sheathing and a tar-and-gravel roofing.

REMODELING

During the past year the building was remodeled. This work consisted in the removal of the center wall between the buildings on the first floor with the exception of 7 ft. in front and 2 ft. in the rear. The plans further provided for a new front and the cutting of a 5 x 7-ft. opening in the center wall in the basement.

This remodeling was done by placing a timber on the basement floor on each side of the wall, one timber under the joists at the basement ceiling line and posts spaced about 3 ft. apart, set with hickory wedges. In the first story a timber was placed on top of the floor at each side of the wall. Immediately underneath the first-story ceiling holes were cut through the brick wall about 4 ft. on centers and a T-rail placed through each hole. At the ends these rails were supported on posts resting on the timbers on the floor. Hickory wedges were then used so that four rails or needles forming a section were jacked up together. Shores and needles were set for about two sections, then the wall for the first column location was cut out and a 12 x 24 x 2-in. cast-iron plate was set on the wall a short distance below the top of the first-floor joists. The location of the first column was 20 ft. 8 in. from the front of the building.

After the plate was set and the column put in place the wall was cut out to within 7 ft. of the front. A steel girder, consisting of two 12-in. 31½-lb. beams, with three separators and bolts, was set with one end on top of the column and the other end on a cast-iron plate set on the edge of the remaining 7 ft. of wall. The space between the top of the beams and the brick wall above was then filled in with brick and cement mortar and wedged with slate and wooden wedges. Three needles and their posts were then removed and placed in another section. A slot was cut for the second column, and the operation was continued as before until all columns had been placed.

CONDITIONS BEFORE FAILURE

When the work was finished the brick wall, including all floors, roofs and ceilings, rested upon brick piers, one at each end, four 7-in. cast-iron columns of varying thickness of metal and five girders. The spans were 13 ft. 8 in. measured from center to center of supports. The columns had integral caps 11 x 11 x 1-in. supported by lugs and rested on cast-iron plates 12 x 24 x 2 in.

Calculations have been made to determine the approximate load per square inch that the girders and columns were required to support. These calculations have been made in the usual way, neglecting possible arching in the brick wall. By referring to the marking of the columns in the accompanying photograph the loads were as shown in the table.

COLUMN LOADS

Columns	Load, lb.	Load, lb. per sq.in.
A_2	130,531	111
B_2	111,046	386
C_2	115,835	402
D_2	115,971	402
E_2	118,813	412
F_2	77,978	271

Previous to the alteration the load was uniformly distributed over 13 ft. 8 in. of brick wall, averaging a unit load of about 63 lb. per square inch. The examination revealed the fact that the cast-iron columns did not rest in the center of the bearing plates, thereby causing unequal bearing on the wall. The committee of eight men which at the request of the mayor of South Bend investigated the failure states that a wall made of common brick laid in lime mortar should not be loaded over 70 lb. per square inch. The wall in question, however, was composed of soft brick and lime mortar below standard. Therefore, the load on the masonry at the time of the failure was more than six times the safe working load. The opening cut in the wall underneath the first floor 3 ft. east of column B_2 weakened materially the bearing capacity of the column.

Floating Swingbridge

A SWINGBRIDGE like a horizontal single or double-leaf bascule, with the moving ends of the leaves supported on floats, is the subject of a British patent issued to J. W. McPherson, of Glasgow. The shore end of the span or semi-span is pivoted and the other end is supported on a suitable float with a swivel bearing, enabling the latter, which is usually supplied with propelling apparatus, to be deflected relative to the axis of the bridge, so that the leaf moves back and forth in the arc of a circle. Where considerable difference in the elevation of the water level is likely to occur the shore end of the span is horizontally pivoted to an apron span with a horizontal pivot at the opposite end, providing adjustment for the different vertical positions of the center span. Small spans may be swung by cables operated by shore windlasses. The arrangement is crude, but might serve for very cheap or hasty construction.

Reinforcing the Manistee Single-Track Viaduct

Capacity of 30 and 45-Foot Plate-Girder Spans Doubled by Trussing

IN a paper recently published by the Western Society of Engineers W. T. Curtis described and illustrated the modification and reinforcement devised by him and executed by the Wisconsin Bridge & Iron Company to double the capacity of the single-track wrought-iron viaduct built by the Chicago & West Michigan Railway Company over the Manistee River in 1888. A résumé of certain features of the paper is here presented.

The viaduct, 1170 ft. long, consisted in the main of fourteen tower spans, 75 ft. high by 30 ft. long, supporting forty-five connecting deck plate-girder spans and one 150-ft. deck truss span across the main channel of the stream. It was originally designed for Cooper's E-25 loading and was reinforced to provide for E-50 loading. Several methods of reinforcement were considered, and it was finally decided to adopt one based on the fundamental idea of converting the upper portion of the viaduct into a series of deep latticed trusses of which the old girders themselves formed the top chords. This was done by adding bottom chords about 12 ft. below the girders and introducing a Warren web system between the two chords thus formed.

OLD GIRDERS

The old girders were figured for the worst condition either of continuous girders or simple spans and were strengthened by additional stiffeners and cross-frames. The old tower columns were relieved by new battered columns in the same transverse planes, running from the lower chords of the new trusses to adjustable bearings on new concrete piers in the center of each bent. The new column bases were provided with pairs of folding wedges adjustable by screws to compensate for any settlement or other irregularity between the three piers of the same bents. This construction virtually reduced the height of the trestle towers about 12 ft. and stiffened the viaducts both longitudinally and transversely. It was completed without interfering with traffic, since the old girders were undisturbed except for drilling holes.

The river span was reinforced by a new deck truss 150 ft. long, placed midway between the old trusses 14 ft. apart, and supported on new vertical columns at the ends. An entirely new lateral system was added below the old system in the planes of the new top chords. The difference in deflection between the new truss and the shallower old trusses was provided for by making the hangers from the old to the new trusses heavier than theoretically required so as to act as equalizers.

WIND STRESSES

Wind stresses in the 30 and 45-ft. spans were provided for by new laterals introduced in the middle panels of the newly formed trestle. From these laterals the wind stresses passed through cross-frames at panel points to the bottom chords of the old deck girders and then through rod bracing in the inclined end posts to the new battered columns. Provisions for irregularities in the old construction were made with numerous shims and a large amount of otherwise unnecessary field drilling.

The detail drawings cost $950 and the total cost of the work was $43,900, which is about half the estimated cost of a new bridge. The field work included drilling about 7000 rivet holes, cutting out 2000 old 3/4-in. rivets, and reaming their holes to 15/16-in. and driving 28,700 rivets. There were erected 455 tons of new steel.

Automobiles for Opening Valves

Device Tested at Trenton Utilizes Power from Jacked-Up Drive Wheel at Curb

A NEW adaptation of the automobile in waterworks service has been tried at Trenton, N. J. It consists in opening valves on water mains by jacking up the rear wheel of the machine and connecting the wheel by light shafts and bevel gearing to the valve stem. The device, which is shown in the photograph on this page, has been developed by W. H. Van Winkle, president of the Waterworks Equipment Company, of New York City. It is adjustable to a motor wheel of any size.

Automobile Supplying Power for Opening Twelve-Inch Water Valve

The apparatus was tested on a 12-in. valve at Prospect Street and Pennington Avenue, Trenton. The valve was closed in 1 3/4 minutes and opened in the same time. It is claimed that the device, when perfected, will lessen the necessity for manual labor in closing valves, as well as increase speed of operation. When in use in any city, rods, gear and attachments, together with the jack, may readily be loaded into the departmental automobile and carried to the scene of action.

OFFICE SUPPLIES used last year on the Baltimore & Ohio Railroad, according to a circular issued by that company, included 700,000 lead pencils, 1,000,000 pens, 23,000,000 pins, 18,000,000 envelopes, 14,000,000 sheets of carbon paper, 23,000,000 second sheets, 11,000,000 rubber bands, 570,000 blotters, 2,500,000 letter fasteners, 2,000,000 file backs, 10,000 sponges and 3300 rulers. They cost $60,000. The company believes half this amount could be saved, and recommends such economies as using metal pencil holders and envelopes of the proper size to inclose correspondence, saving pins and paper fasteners instead of discarding them and using cheap paper instead of expensive linen sheets for memorandum purposes.

Meter Tests at San Diego

ENDURANCE and accuracy tests on fourteen 5/8-in. meters were carried out in December, 1913, at San Diego, Cal., by connecting the meters in the regulating chamber at Sixteenth and F Streets between high and low-service mains on which daily readings indicated pressures of 165 and 62 lb. respectively. During the endurance run the meters were removed and tested in the repair shop with the Mueller water-meter tester under 12, 10, 8, 6, 4, 2 and 1/2-cu. ft. flows, represented respectively by 5/8, 1/2, 3/8, 1/4, 1/8, 1/16 and 1/32-in. streams.

Most of the meters had passed about 200,000 cu. ft. of water before being subjected to the final test. New, the accuracy of the fourteen meters on 5/8 and 1/32-in. streams ranged from 97.63 to 100.75 per cent, eleven of them registering within 1 per cent of perfect. At the final test nine meters were absolutely accurate within 1 per cent on the seven different streams noted above—one meter was within 1.1 per cent, a second and third within 2.18 and 4.89 per cent respectively and two meters failed to register. The latter originally were perfect within 3 and 1.25 per cent. One of the meters, which showed 4 1/4 per cent under-registration on a 1/16-in. stream and no registration on a 1/32-in. stream, was found with the disc worn so that the "leak" streams would not register; otherwise the meter was in good condition.

The tests were carried out under the direction of H. A. Whitney, hydraulic engineer, reporting to Maj. Herbert R. Fay, superintendent of the San Diego Department of Water.

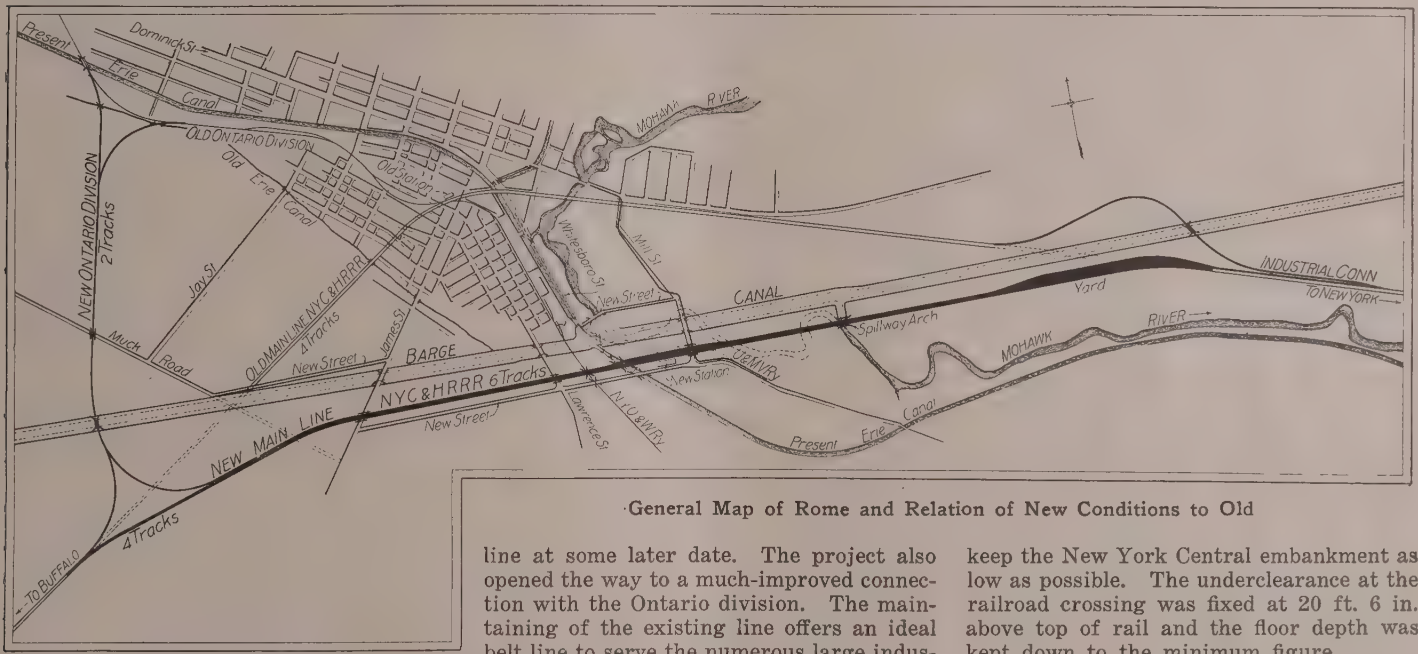
Rapid Steel Erection

THE 141 x 275-ft. steel foundry building for the National Brake & Electric Company at Milwaukee contains 536 tons of structural steel, which was erected in 56 actual working hours by the Worden-Allen Company. The building has three longitudinal rows of columns, one crane runway, roof trusses over the 60 and 81-ft. aisles, and a monitor over the latter. The steel was erected by a traveler having two stiff-leg derricks with 75-ft. steel booms mounted with the hoisting engine on a 30 x 30-ft. platform moving on a surface track which extended from end to end of the building.

New York Central Change of Line at Rome

Relocation through City to Avoid Costly Barge Canal Bridges, at the Same Time Shortening Route and Eliminating Grade Crossings

FOLLOWING closely the route of the old Erie Canal and the main line of the New York Central & Hudson River Railroad from Albany to Buffalo, the New York State Barge Canal, as laid out, crossed the railroad at some twenty-odd points in a manner requiring the relocation of main-line tracks, the reconstruction of bridges or the building of new ones. One of the most important of these "interferences" was at Rome, where, except for the relocation of the railroad, two four-track bridges at almost prohibitive skews would have been necessary. The very large expense of these bridges led the State people to consider ways and means of avoiding at least a portion of the outlay, and among others the plan of changing the location of the New York Central main tracks proved the most attractive from a financial viewpoint. In the solution of the problem these costly crossings are avoided and the main line is shortened 1670 ft.; all main-track grade crossings throughout the city are eliminated, and the city will be further benefited by an exceptional belt line for industrial purposes.



General Map of Rome and Relation of New Conditions to Old

REASONS FOR CHANGE

Under the old conditions, as the general plan shows, the main line makes a sharp turn in the heart of the city, the station being on the curve. The business center is just across the Erie Canal to the north, mainly on Dominick Street, and there are a number of dangerous grade crossings on the curve. The Ontario division branches off in awkward fashion immediately west of the station and winds its way out of the city, and on this there are also several grade crossings.

To reach the city without passing through the built-up section it was necessary to locate the Barge Canal on the south side of the town, and as laid out this would have involved the crossing of the east railroad tangent on an angle of about 17 deg. and the crossing of the west tangent on an angle of about 37 deg. Payment for these various railroad changes necessitated by the Barge Canal may fall upon the railroad company if the canal is in the channel of a navigable stream, but if that is not the case the expense falls upon the State. The Rome improvements come in the latter class, and it was found upon investigation that the estimated cost of the two crossings mentioned would go a long way toward relocating the railroad to keep it south of the canal, considering the possibility of getting embankment at a low cost from the material excavated from the canal prism.

From the railroad point of view the advantage was augmented by the ease with which the new streets intersecting the projected line could be carried under the tracks, avoiding the heavy expense of eliminating the eight grade crossings on the old line at some later date. The project also opened the way to a much-improved connection with the Ontario division. The maintaining of the existing line offers an ideal belt line to serve the numerous large industrial plants in the city and makes room for the expansion of the present cramped local freight facilities at the old junction without buying additional land in the heart of the city. These advantages were considered ample to warrant the construction of the two double-track Barge Canal bridges, one at the east end to connect the industrial tracks and the other at the west to accommodate the Ontario division. Sharp skews in these bridges could be readily avoided.

From the city's point of view the elimination of the grade crossings at little cost to itself was highly desirable, and the benefits from the belt line were obvious. These features, with the erection of a new and suitable station and the fact that a frequent street-car service was available, reconciled the people to the fact that the new station would be of necessity almost a mile from the business center of the city.

LOCATION AND PROFILE

Throughout the improvement the ground is flat, and there is nothing to fix the new alignment absolutely. To minimize the haul the main line was located as near the canal as possible, leaving room to get the streets over the canal and under the railroad with the necessary clearances and suitable grades. The Ontario division connection was located far enough west to permit a swing around to practically a right-angle crossing over the canal.

In the matter of profile, the chief problem that presented itself was the disposal of the branch line of the New York, Ontario & Western Railway terminating at Rome, it being necessary to give standard clearance of 15 ft. 6 in. above high navigable water at this company's bridge over the canal, and yet avoid a grade crossing over the New York Central. In order to keep the main-line embankment down consideration was given to the possibility of carrying the New York, Ontario & Western over it, but this idea was abandoned as impracticable on account of the impossibility of getting the elevated tracks of that road down in time to serve the large plant of the Merchant Iron Works just north of their engine house. It was, therefore, decided to carry the Ontario & Western under and use short 1½ per cent grades in order to keep the New York Central embankment as low as possible. The underclearance at the railroad crossing was fixed at 20 ft. 6 in. above top of rail and the floor depth was kept down to the minimum figure.

USE OF ARCHES

The necessary elevation at this point provided ample headroom at the street and waterway crossings, and arches were adopted for all of the bridges except the one over the Ontario & Western and those over the Barge Canal. These arches are reinforced-concrete structures of standard design—all of them, as well as the bridge abutments, being on piles with the exception of the double spillway arch, where a good gravel foundation was obtained and piles were omitted.

In its original location it will be noted that the Utica & Mohawk Valley Railway (electric) turned west from Mill Street, followed the new railroad right-of-way some 2000 ft., and then passed to the north and entered the city via Whitesboro Street, along the east bank of the Erie Canal. On account of the close proximity of the Mohawk River, the Erie Canal and the New York, Ontario & Western Railway, as well as the projected lock and Barge Canal harbor in this vicinity, it was not feasible to provide for the electric railway on its old location. The line was therefore relocated as shown on Mill Street, provision being made to carry it across the industrial line

View of Double Spillway Arch near East End of Improvement

and connect with the city line after the relocated New York Central is in service.

The double arch accommodating Mill Street and the Utica and Mohawk Valley Railway is somewhat unusual on account of the two unequal spans. Details of the arch ring are shown in cross-section.

The three single arches over the Erie Canal, Lawrence Street and James Street, as well as that of the Ontario division over Muck Road, are similar in general design. The State requires that the Erie Canal be kept open, and the towpath is carried through the arch as a narrow independent wooden roadway on piles. The street crossings are outside of the built-up section of the city, and it was permissible to narrow them at the arches. Muck Road is of little importance, and will be diverted to avoid a Barge Canal crossing and a main-line crossing, or possibly abandoned altogether from Jay Street east.

NEW STATION

Considerable study was given to the location of the new station. At one time it was proposed to build it between Lawrence and James Streets. This is a more central location than the one adopted, but the latter has the advantage of being adjacent to the Utica & Mohawk Valley Railway. The station, which is nearly finished, is in keeping with the modern trend toward ample and ornamental stations. The island platforms are reached by a broad subway, with stairways on one side and baggage lifts on the other.

To reach the station from Mill Street and provide direct connection with all of the streets running to the south a new street is being built parallel with the new line and immediately south of it. This involves two additional bridges, one over the Erie Canal and one over the Ontario & Western. The latter has been completed, but the former has been held up by the State authorities on the ground that its close proximity to the narrow canal opening under the railroad embankment would be an obstruction to navigation. This question has not as yet been settled.

In the bridge for the industrial tracks over the Barge Canal at the east end of the improvement no special difficulties were encountered, and the bridge is in place ready for service. At the west end, at the Ontario division crossing, however, the foundation conditions were found to be unfavorable, and it became necessary to change the design to convert the abutments into piers, introducing a short span at each end and building new abutments of lighter cross-section farther from the bed of the canal. The design is similar to that adopted for the West Shore Railroad bridge over the Barge Canal at Montezuma, N. Y., which was described in the Engineering Record of June 1, 1912, page 612.

A number of large industrial plants are located along the main line east of the station, and it is proposed to leave in all of the present tracks, those not used as mains to be retained for storage and switching. West of the station the existing main-line tracks will be left in as far as the Barge Canal, and the Ontario division tracks will also remain to complete the belt line. If any changes are to be made in the freight-house and team-track facilities they will be treated as a separate proposition, but a small yard, with a capacity of six 60-car trains, will be built at the east end near the industrial junction to provide additional storage and switching facilties for local business. The two Ontario division main tracks will be carried through past the new station and this yard to the easterly interlocking plant, where the industrial connection also joins the main line.

DETAILS

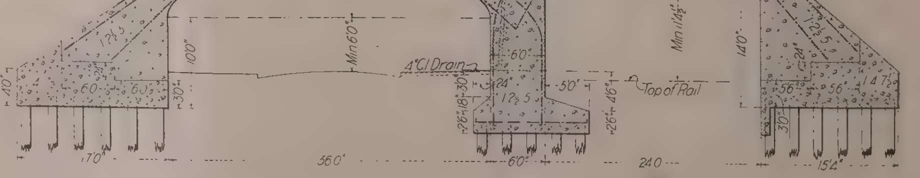
The main-line relocation is about 20,000 ft. long, the approach grades at either end overlapping the present main line for several hundred feet in order to preserve the ruling gradients. These gradients are 0.25 per cent in each direction, compensated 0.04 for curvature, but a short westbound grade of 0.4 per cent has been introduced in the passenger tracks at the east end in order to make room for a level space for track pans near the spillway double arch without too much raising of present main tracks under traffic. Tracks 1 and 2, for passenger service, have been laid with 105-lb. rail on stone ballast, and tracks 3 and 4, for freight service, with 100-lb. rail on gravel ballast. Creosoted ties with tie plates are being used for all tracks. The Ontario division relocation is about 8000 ft. long; the gradients are not entirely determined.

In the entire improvement there will be more than 1,800,000 cu. yd. of embankment. This is almost entirely hydraulic fill, made from the material dredged to form the Barge Canal channel. One general contractor has the entire work, including the canal-prism excavation, railroad embankment and all concrete structures—not only those specifically mentioned, but also a number of other structures in which the railroad is not concerned. A large part of the dredged material is good clean gravel, and this is being used for the concrete. The improvement was started in the spring of 1910, and it is expected that another year will be required to complete it fully, although the new main line has been put into service.

PERSONNEL

The M. A. Talbott Company, of Baltimore, has the general contract. With this company are associated Grant, Smith & Company & Locher, of New York City, who are handling the excavation of the canal and the railroad grading. The Pennsylvania Steel Company is furnishing the general contractor with the steel. A. E. Badgley, of Binghamton, N. Y., has the contract for the station and also for the pump house near the spillway double arch to supply the track pans.

The New York Central work is being carried out under the general direction of George W. Kittredge, chief engineer, and J. W. Pfau, engineer of construction. G. P. Stowitts, chief draftsman, had charge of the design of the arches and the station subway. A. W. Carpenter, formerly engineer of structures, had charge of the bridge design, and D. R. Collin, architect, was the designer of the station. E. B. Menuez, district engineer, has immediate charge of the construction work. J. D. Black is resident engineer on the ground, J. B. Reinhardt and G. F. Chism having been the resident engineers at earlier stages of the work.



Cross-Section of Unsymmetrical Double Arch at Mill Street

Design of Reinforced-Concrete Retaining Walls

IN the letter to the editor by Donald N. Becker, published in the Engineering Record of Jan. 17, page 86, several mathematical errors have been discovered. Equation (1) should read $f_s = nf_c\,(d - kd)/kd$. In equation (2) the term $(d + kd)$ should be $(d - kd)$. In the equation for f_c near the foot of the second column the term $(12 \times 9\frac{1}{2})$ should be $(12 \times 9/2)$, and likewise in the equation for the value of f_c near the top of the third column the term $(12 \times 8\frac{1}{2})$ should be $(12 \times 8/2)$. At the end of the twenty-first line of the third column the expression should be (17,900 — 16,000), and in the equation for A_s in the thirty-eighth line the term $(16{,}000 \times 9 \times 26.5)$ should have been $(16{,}000 \times 0.9 \times 26.5)$.

In the second column on line seventeen from the bottom the figure $2\frac{1}{8}$ is given. This is incorrect, as it should have been $2\frac{3}{8}$, which slightly affects the value of M' and consequently the unit stresses in the equations following.

The Making of a Technical Journal

Abstract of Address Delivered before the Western Society of Engineers on Feb. 2 by E. J. Mehren, Editor of the Engineering Record

PRIMARILY the technical journal was established to supply the engineer with information as to the latest developments in his field. If this had remained its sole object it would have remained on practically the same basis as the journal of the engineering society. It was recognized in the early days of technical journalism, however, that execution was quite as important in engineering as design, and space was, therefore, devoted to the methods employed in carrying out the work planned by the engineer. Naturally the contractor or builder was interested in construction methods. He became a reader, and to serve him better it was a logical step to give space to descriptions of construction equipment and news of proposed enterprises. Manufacturers spend millions of dollars annually in investigations and experiments, which come to light, as a rule, only through improvements in their products. To neglect these products, then, is, journalistically, to cast aside the fruits of much well-spent money and leave unknown devices which may be the means of large savings to the readers.

The technical journal of to-day, therefore, is not strictly a professional journal. It emphasizes quite strongly the business side of the profession. As an evidence of its work along these lines we may recall the contracting news sections which occupy a place of much importance in many technical journals.

EDITORIAL ORGANIZATION

The object of a technical journal being to gather from all parts of the country—and of the world, for that matter—data and news of value to its clientele, the collecting organization must evidently be an extensive one. The machinery for gathering this material can be classified under three heads: (1) A permanently employed editorial force; (2) correspondents and contributors, and (3) a comprehensive clipping service. The permanently employed editorial staffs of the larger engineering journals have as many as nine or ten editors, supplemented by as many trained clerical assistants. All of the editors have an engineering training. Most of the editors are located at the main office of the journal, while the character of the specialty covered governs the points at which the others are located. The staff generally includes four or five specialists, confining their attention to one, or, at most, two lines, and a number of general men. Correspondents are located in every large city throughout the country and are relied upon to furnish promptly news of special interest to the journal The clipping service is supplied in part by clipping bureaus and in part by a department in the head office of the journal, which reads representative newspapers from every part of the country. The clippings, however, are not assumed to be correct and are used simply as clues, to be followed by letter or telegraphic verification, and, in the case of important matters, by personal attention of a correspondent or member of the staff. The secret of prompt and reliable news gathering lies in the development of a strong and interested clientele. Such a clientele is the chief asset of a technical journal.

In the case of matters of great importance, such as disasters to large engineering structures, reliance is seldom placed upon outside contributors. For example, when the seriousness of the Dayton flood was realized there was an exchange of telegrams between the Chicago and the New York offices of our journal and our Pittsburgh correspondent. The conclusion was to send the Western editor from Chicago to attempt to get into the flooded district from the north and to dispatch two representatives from Pittsburgh to attack the situation from the east. As these men were starting, telegrams were poured into every city affected and correspondents urged to dispatch authentic material immediately. As a result, in the issue of the week following the flood there was a six-page report giving authentic data upon the disaster, and accompanying it was an insert plate with pictures of destruction at strategic points.

COVERING A DAM FAILURE IN WEST VIRGINIA

As another instance of hardship suffered in gathering data for the technical press may be cited the occurrences at the time of the recent failure of a concrete dam on the Stony River, in West Virginia. There was the usual marshaling of forces and the dispatching of one of the editors to the scene. A trunk line railroad runs within 15 miles of the dam site, but from that point the only transportation is over a logging spur. The editor arrived at the junction with the spur on Saturday morning, Jan. 17, two days after the dam failed, and found a driving blizzard crippling the branch road. Nothing could be done that day and at 5 o'clock on Sunday morning he began to walk to the dam site, following the railroad right-of-way, plodding through heavy snow into which he sank from a few inches to 2 ft. at each step. The scene was reached, notes made, conclusions formed and photographs taken in time to catch the logging train, which had just extricated itself from the drifts. In twenty-four hours the films were developed, the story written and material being put in type.

CONTRIBUTORS

The number of engineering contributors is very rapidly increasing. The managing editor of our journal stated several days ago that if no additional contributions were received for the next four months the supply on hand would be ample to fill the space which will be available after matters requiring immediate attention have been provided for. All the material is of first-class quality. Its great fault, however, is in its length, and this fault is characteristic of practically all contributed material. The engineer naturally feels that his own project is of transcendent importance and, instead of picking out the unusual or most interesting features, he describes details that are of interest only to himself and to his associates in the work. The result is not only a great waste of his own time, but the probable rejection of the manuscript. It not infrequently happens that an article, rejected solely because of its length, is returned cut down one-half. The resulting article is much better than the first draft.

Every reader of a technical publication should be a potential contributor. Certainly at least once a year something occurs in his practice that is worth while passing on to his brothers. If he will put it in the shortest possible form, his effort will receive a hearty welcome from the technical editor. Five one-column articles are preferable to one five-column article.

As to the editorial staff itself, no single problem in technical journalism offers so much difficulty. The men must be engineers by education and preferably by experience, must have ability as writers, and last, but not least, must have strong personalities, because only such can deal forcefully with situations and make the impression necessary to secure the confidence of the engineers with whom they deal. If some formulæ could be devised by which such men could be infallibly picked, the saving of time to the editor-in-chief would be very large. As it is now, only men of apparently special aptitude are given a trial, and even then the mortality is at least 50 per cent. The work of training is laborious and long.

THE TROUBLES OF EDITORS

Some of the difficulties experienced by the technical editor may help to a clearer comprehension of the work involved in the making of a technical journal. Probably the chief difficulty is presented by the tremendous amount of material which daily must pass over the editor's desk. This consists not only of routine letters but of contributed and staff articles, with their accompanying blueprints and photographs; special and annual reports, press bulletins, proceedings of technical societies, clippings, catalogues, and a mass of miscellaneous material. It is a conservative estimate, leaving aside bulky printed reports, that fully twenty times as much printable material passes over the editor's desk as is actually used. But whatever the material, it cannot be passed over slightingly but must be examined by someone familiar with the policy of the journal and the history of each of the principal engineering specialties, in order that the new may be separated from the old, the correct from the incorrect, and that articles with "an axe to grind," or which may injure the character or professional reputation of an engineer, may be discovered. There is imposed upon the technical editor, naturally, a grave responsibility. By passing judgment without having all the facts clearly before him he may seriously prejudice engineers and the public against a meritorious project, may injure the reputation of a practitioner and may permanently injure the standing of his journal. This responsibility is fully appreciated in the offices of the higher class technical publications, and sooner than do damage, in doubtful cases, to the reputation of an individual or an organization judgment will be reserved even if there is danger of being accused of being weak.

It is true that the technical journalist does not originate. It is for those in professional practice to make the advances. The journalist's duty is to observe and interpret them. While, therefore, he is likely to lose his appreciation of details, that loss is more than compensated for by the advantage of being able to stand off at a distance and to observe a movement or a new process without the warping tendencies which come from too close attention to details. In this way the technical editor should be able to see the philosophy of the development going on under his eye and to present aspects and relations that will be an inspiration to those whose duties keep them closely confined to details or to one specialty.

In recent years there has been a marked tendency to emphasize the news pages of the technical journal. Ten years ago these were quite subordinate. When important events occurred they were duly chronicled, because it was quite evident that the field would be interested in them. It was not appreciated, however, that a bird's-eye view of the field for the week came not from the mere reporting of the outstanding events, but from gathering up from the four corners those little items which more surely denote the general tendencies. For that reason the development has been toward a great many short items, written in newspaper style, so that they could be passed over readily, leaving the reader in an hour with a complete survey of the field for the week.

THE "HUMAN" SIDE

With this tendency to give more attention to current news has come also an appreciation of the necessity of appealing to the human side of the engineer. The technical journal of the past has been characterized by a "deadly sameness," which tempted one to leave one's copy in the wrapper until it was time to send the whole volume to the binder.

The type arrangement did not change from year to year, illustrations did not receive adequate attention, and the editor scrupulously blue-penciled any sentences or phrases that had in them the least human interest. The sentiment in the offices of technical journals, however, is changing rapidly. More and more appeal is being made through pictures rather than through the printed word. The picture gives an immediate impression—the word is a slower medium. Moreover the printing art itself has undergone rapid changes and standards have been erected which have raised typography to the level of an art. These things are taking hold upon technical editors. The evidences can be found in many journals of the present day and portend marked improvements within the next few years. The changes are being made, too, without detracting from the technical excellence of the journals.

Moreover, much is being learned from the newspapers. Long articles are in disfavor. Particular emphasis is being placed upon the correct writing of the introduction to the article. Unless the first paragraph shows the reader why he should read the whole article, the copy goes back to the sub-editor for rewriting.

PLACE OF THE ADVERTISER IN TECHNICAL JOURNALISM

It is hardly necessary to point out that if magazines did not have advertisers the technical journal, as we know it to-day, could not exist. It costs from $12 to $17 per annum to send a high-class technical journal to a subscriber, yet he pays but $3 or $5 for it. From $9 to $12 must, therefore, be taken from the advertising revenue and paid out in expenses for each subscriber on the list. That advertising is necessary in the technical journal is, therefore, not open to argument.

There has come about, however, a very marked change in the attitude of manufacturers who use space in engineering magazines. In former days the signing of an advertising contract was considered by many advertisers as guaranteeing to them a certain amount of space in the editorial pages, wherein their products would be boomed and personal notes about members of the organization printed. Weaker papers did allow their editorial pages to be thus prostituted, but while the best papers from their very foundation, thirty-five to fifty years ago, have not permitted this, it is only recently that advertisers have seen the light and have concluded that a journal which does sell itself editorially cannot gain or hold the confidence of its readers and is, therefore, not a good advertising medium.

THE FUTURE OF TECHNICAL JOURNALISM

What will be the future of technical journalism? Those in the work who are gifted with vision see wonderful opportunities for expansion and better service to the clientele. Beyond that, however, is an ideal to which the technical journal should and is aspiring—to play a larger part in educating the public in matters having an engineering aspect. Right thinking is needed, for example, on the part of the people at large regarding the valuation of public utilities for purposes of rate making. Theories widely prevalent are confiscatory of private property. What agency is so well-fitted as the technical journal to expound sound doctrine? What medium is more suitable for linking up scientific principles, facts and the public interests on such matters as the pollution of streams, the prevention of floods, the sane development and financing of highway systems, and the writing of building codes? All of these rest on an engineering basis.

Furthermore, the public needs education as to the status of engineers and the advisability of appointing them to public office largely concerned with engineering work. Here again the technical journal should be qualified to speak.

But how can that influence be exercised? The general public does not read engineering magazines. The scheme is to exercise that influence on the newspapers of the country and have them pass the doctrines on to their readers. Already great progress has been made along these lines and better relations are established to-day between the technical press and the newspaper editors than ever before. Important and interesting items are taken from the journal each week, boiled down, freed from technicalities and distributed to the newspapers of the country. The result is a weekly broad dissemination of engineering information. But the technical journal should not be alone in this work. Working side by side with it should be the local society. The technical journal can do two things for the technical society: First, assist it in its technical work by reprinting abstracts of important papers, giving due credit, of course, to the society; and, second, by publishing news as to its public activities and encouraging all organizations of the same type to assert themselves, and thus do their part in spreading the influence of the engineer and raising his status. The technical journal and the society have, in the last analysis, the same aim—the good of the profession. They should be partners, each working effectively within its own sphere.

Both should realize their co-partnership, for such realization is the forerunner of co-operation, and by co-operation they will the more effectively carry out their program—the advancement of the profession and of professional knowledge.

London to Send Mail through 9-Foot Tube

A DOUBLE 9-ft. tube, similar, except in size, to those of the tube railways, is being built for the carriage of mails and parcels east and west, from one end of London to the other. The movement of the cars will be controlled from three intermediate stations, no motorman being employed. The steel cars will be 3 ft. 7½ in. high and 2 ft. 10 in. wide, running on a 2-ft. track over 6 miles in fifteen minutes, or, inclusive of stops, 24 miles per hour. The current driving the trains from the existing post-office power house will be transformed down to a working pressure of 400 volts. Each of the stations, which will form future junctions for north and south branches, will consist of an island platform, arranged in two sections, between which will be placed a control cabin and the lifts and conveying appliances that have been specially designed to suit the different classes of mail matter which have to be dealt with between the station platforms and the postal buildings above.

It is proposed to operate the trains by three types of current, which are designated as high speed, intermediate speed and low speed. Between the stations high-speed current will be applied. There are arrangements by which when a stopping train approaches a station the low-speed current will be substituted, and when a through one is passing the intermediate-speed current will be applied. Dalrymple Hay, M. Inst. C. E., is the engineer for the construction of the tube, and the engineer in chief for the general post office is responsible for the equipment.

County Bridge Investigation in Kansas

AN investigation of the condition of highway bridges in Clyde County, Kansas, has recently been made by A. H. Worley for the county commissioners. In a twelve-day automobile tour of inspection he examined 291 bridges and culverts and reported on their strength, condition and the attention they required.

The culverts were all semicircular arches of thin local limestone of a very soft and porous character, and were provided with spandrel and wing walls to retain the earth-fill. Most of them had spans of 5 to 7 ft. and were built of dry masonry, lime-mortar masonry and cement-mortar masonry. The first two classes had deteriorated badly where exposed to water and the removal of the crumbled stone and its replacement with small sections of concrete were recommended. Several wooden truss bridges were found badly decayed and wooden trestle bridges were found with very weak and unsafe floors.

Some of the steel bridges were of very light construction and subject to severe vibration. A number of them were supported on light steel columns with timber sills and without any protection against rust below the surface of the ground. Generally the worst feature of the steel spans was the decayed condition of the wooden stringers.

The report gave principal dimensions, materials and other data, and stated the safe live load for each structure. It also gave plans for emergency and future repairs and for auxiliary improvements. It was noted that few of the steel bridges had even been painted since erection.

Laying Out New Water-Supply System for Victoria, B. C.

27.3-Mile Gravity-Flow Concrete Pipe to Convey from Sooke Lake 16,000,000 Gallons Daily; a Balancing Reservoir, and a 10-Mile Steel Main

VICTORIA, the capital city of British Columbia, situated on the south end of Vancouver Island, had its first water system installed in 1868, when a private company pumped from wells and delivered through wooden pipes, making a charge of 0.75 cent per gallon. In 1872 Elk Lake was first studied as a possible source of supply and was rated as capable of furnishing 25 gal. per capita per day for a population of 90,000. As later constructed by the city, the Elk Lake supply, after passing through open gravity sand filters, was delivered to the city in low and high-pressure zones by a gravity system.

The necessity for increased supply and for greater fire pressure led to the installation of a pumping plant in this system, and when the daily consumption reached about 2,000,000 gal. the lake level was lowered thereby and the quality of the water impaired. At this time Victoria West was supplied by water purchased from the Esquimalt Waterworks Company, a private corporation which owned rights on the Goldstream Lakes.

WATER RATES

About 5,000,000 imp. gal. were supplied to the city of Victoria in the dry months of 1913, the maximum daily rate per capita during these months being about 80 gal. The water taken from Elk Lake costs the city about 2 cents per 1000 imp. gal., while the price of water from the Esquimalt Waterworks Company is fixed by charter at 6 cents per 1000 imp. gal. The latter rate was considered excessive, as was also the price which the company asked for its holdings, and in June, 1912, after the proposition of an additional water supply had been under consideration for several years, it was decided to construct a supply system from Sooke Lake to the city.

The most practicable scheme among the various projects considered seemed to be to reservoir Sooke Lake for a 12-ft. lift of water level and lay a 40-in. concrete pipe on a slope of 1 in 1000 to an artificial lake known as Humpback reservoir and located about 10 miles outside the city. The pipe is to be laid on the surface and the route traversed between the two reservoirs is 27.3 miles long. From Humpback reservoir a 36-in. steel pressure main will lead to the Smiths Hill service reservoir, which is located in the city at an elevation of 213 ft. above sea level and has a capacity of 16,000,000 imp. gal.

PRELIMINARY AND LOCATION SURVEYS

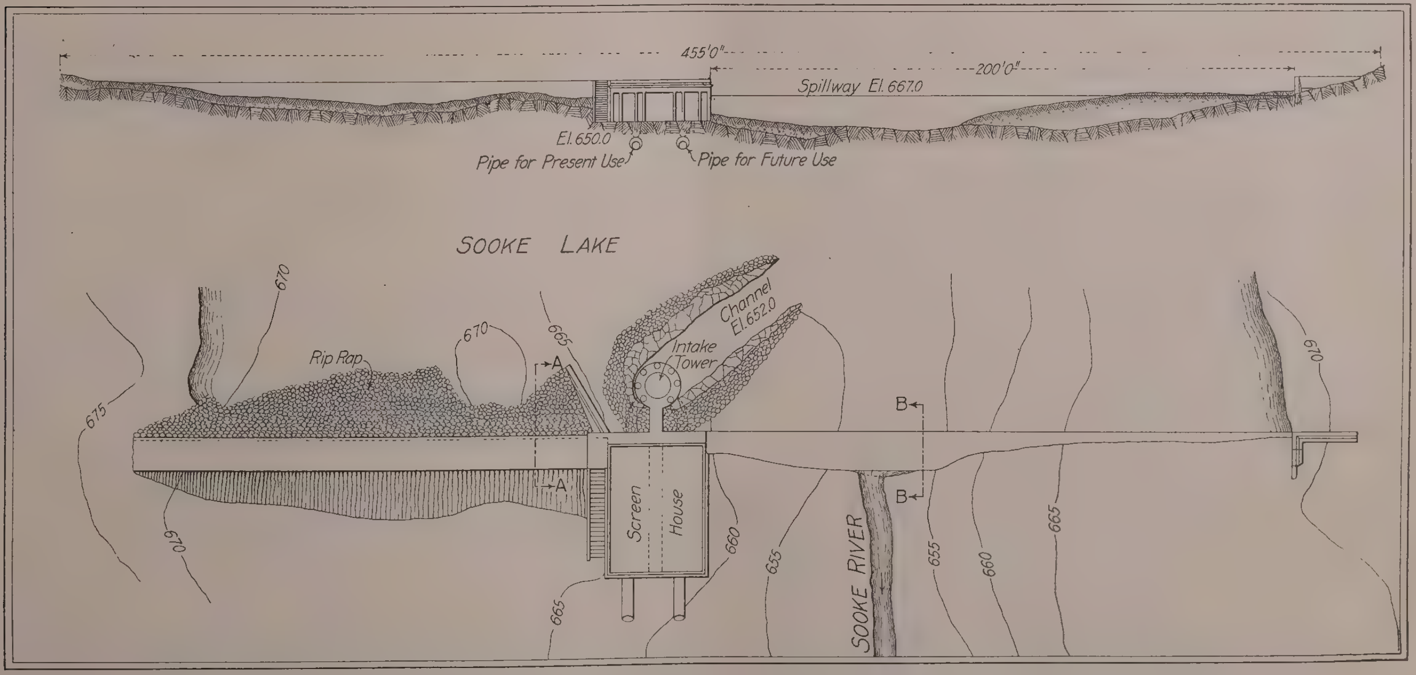
On July 1, 1911, when the city decided to take up active work on the extension of its water supply, there were no hydrographic data or maps in sufficient detail to decide any of the engineering questions at issue. Gaging stations for rainfall and rated sections on the Sooke and Leech Rivers were established at once, while engineering parties proceeded with a contour survey of Sooke Lake, running traverses of the various pipe lines that had been under consideration and determining the areas of the Sooke Lake and Leech River watersheds. These surveys were through thick forests of Douglas fir and over very rough country. Often precipitous rocky bluffs, difficult of access for work or for the transportation of supplies and equipment, delayed the progress, and since the work extended into the winter, working conditions were very trying. The time at which it was proposed to submit the project to popular vote necessitated expeditious work in order to get even the preliminary surveys in shape for the general plans and specifications. This was accomplished, however, and tenders of contractors were received Dec. 15, 1911.

In the work of adjusting a gravity grade location for the concrete pipe the same difficulties of dense forests, rocky bluffs and a winter season had to be contended with. Surveys and locations closely followed the methods used in railroad work. No angles of more than 3 deg. were used at the joints, and concrete pipe was assumed to be in 4-ft. lengths, while the steel pipe was considered as being in 22-ft. lengths. The roadbed for the concrete pipe, which was generally in sidehill work, was staked for an 8-ft. width. Tile pipe was laid for drainage openings, steel bridges were designed for the siphon crossings, and reinforced concrete trestles for the wide drainage openings and approaches to the bridges.

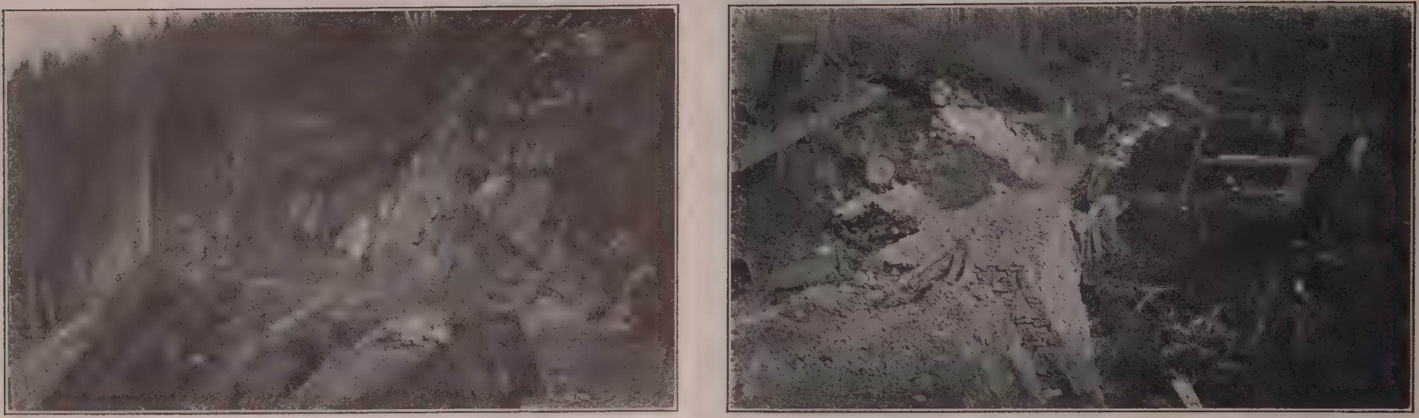
SOOKE LAKE

Sooke Lake lies to the northwest of Victoria, about 18 miles distant as the crow flies. It is about 4 miles in length and ½ mile wide at its maximum width. Two narrows divide it into practically three lakes, of which the upper and largest has a maximum depth of 150 ft. Its main feeders are Ferguson Creek on the east side and a very large spring directly opposite on the west shore, which supply a total of about 3 sec.-ft. in the driest seasons of the year. The area of the lake at low water, which is 555 ft. above sea level, is 964 acres, and the total watershed area is 31.33 sq. miles. This watershed, rising in places to more than 2500 ft. in elevation, is densely wooded with Douglas fir, and except for the narrow flat around the lake shore has a steep slope of precipitous bluffs of trap rock. It is bounded on the east by the Leech River watershed, 30.33 sq. miles in area, and joins the watershed of the Esquimalt lakes on the south.

In the scheme for the ultimate development it is proposed to utilize the Leech River water supply by building a diverting dam in the stream and a 5-mile conduit to convey water to Sooke Lake. When this is done a dam rising to a height of 45 ft. above the present low-water level of the lake is projected, and it is estimated that a daily flow of 100 sec.-ft. will be available, while the reservoir storage above low-water level will be 17,358,000,000 imp. gal. The initial project now under way, by the use of a concrete dam at the outlet, will raise the



Plan and Section of Sooke Lake Dam, Showing Intake Channel and Pipe Connections from Screen House



Typical Cut and Fill on the Line of the Sooke Lake Water-Supply Pipe Line

lake 12 ft., and this will give a reservoir capacity, above low-water level, of 3,355,000,000 imp. gal.

The provision that the margin of Sooke Lake should be cleared to 15 ft. above low water affected 300 acres of thick forest, which had to be cut down and burned. About 2 miles of wagon road along the lake shore had to be built at this high-level elevation, and it was provided that the Canadian Northern Railway should build its proposed line at an elevation 50 ft. above low water, to admit of the ultimate project to reservoir the waters of the Sooke and Leech River watersheds to a height of 45 ft. above low water.

Intake and Dam

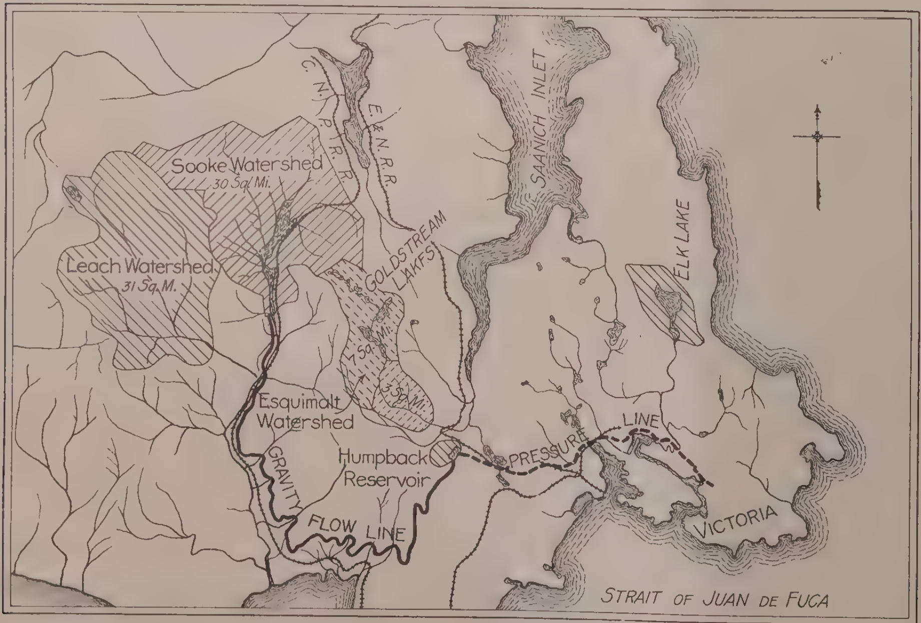
At the dam the intake channel is excavated 4 ft. below low water, and there will be an intake tower controlled by seven sluice gates, three 30 x 42 in. and four 24 x 30 in. The gate openings will be protected by bar screen cages anchored in the concrete. From the intake tower two 40-in. riveted steel pipes will be laid to conduct the water to the screen house, but only one of these will be put in service at present. In the screen house will be installed a set of twelve screens with a mesh of 40 openings to the inch. Below these are the measuring weir and cascade steps to the conduit pipe at a grade elevation 12 ft. below the low-water level of the lake. The screen house will be of concrete with a concrete roof and windows protected by wrought-iron grillages. A sink will be provided with water under pressure from a 6000-gal. tank for washing the screens.

The dam will be a composite structure, the west end being an earth embankment, with a concrete core wall bonded into the natural rock. Then comes a reservoir section wall with a screen house at its back. From the screen house to the east abutment an ogee weir section 200 ft. long will be used, which is generally about 15 ft. above the foundation of natural rock. This will be bonded into the rock with a cutoff trench at the upstream face. About 2200 bbl. of cement will be used at the site, which will have to be hauled 9 miles from Fitzgerald's station on the Esquimalt & Nanaimo Railroad.

Concrete Pipe Line

A consideration of the three alternative bids on wood-stave, riveted-steel, and reinforced-concrete pipe resulted in favor of the last-named type, largely on account of its permanency and economy. The initial development is being carried out with a single pipe line, 40 in. in diameter, which is to give a daily supply of approximately 16,000,000 imp. gal., this being calculated as sufficient for at least 200,000 people at Victoria's present rate of consumption. The flow in the pipe was estimated for $C = 120$ in the Chezy formula, or $n = .012$ (about) in Kutter's formula.

The reinforced-concrete pipe is designed with a 40-in. inside diameter and a 3-in. thickness of walls. The reinforcement will be wire mesh with an area of 0.043 sq. in. per foot of pipe and a 0.025-sq. in. sectional area of cross wires per foot. The pipe, which will be built up along the line in 4-ft. lengths, is to be of the type patented by the Lock Joint Pipe Company, of New York.



Map of Watersheds, Reservoirs and Pipe Lines for Sooke Lake Supply

As no materials suitable for making concrete occur along the grade, it will be necessary to establish a pipe yard where these can be made. The finished pipe will then be hauled up an incline railway to the grade and conveyed to the desired point by the construction railway on the conduit roadbed, which will also be used in the erection of the various drainage structures. The pipe will be leveled to grade and supported upon crushed-stone ballast.

A right-of-way 100 ft. wide was secured for the pipe line, and all trees in this strip were cut down, as were also all high trees outside this strip which might reach the pipe in falling. It is not proposed to cover the pipe except in the deep cuts where slides might occur. At each 2000-ft. point on the conduit line there will be an open standpipe, and all inverted siphons will have waste outlets at the bottoms controlled by 6-in. gate valves. All inverted siphons are to have steel reinforcement, varying in quantity according to the head. Anchorages and expansion joints are specified where necessary.

Drainage Openings

The drainage openings along the flowline grade are of several varieties. For the smallest drainage the water will be carried along and passed under the pipe line by small holes through the ballast at points where the roadbed is in the rock. For a somewhat larger volume of water concrete side walls will support the pipe where the span requires it, and if the crossing is at a point where earthy material occurs it will be protected from scour by concrete. This refers to the shallow openings practically at grade; but where there is some embankment, vitrified pipe from 12 in. to 24 in. in diameter will be used; for a still larger volume, open ravine culverts of 15-ft. span with a concrete girder and saddles will support the pipe, while 45 to 80-ft. steel bridge spans with concrete abutments will be used to cross streams at low points of the siphons. Six siphons are required, and these will be laid to precise horizontal and vertical curves. The deepest siphon is 600 ft. long and has a maximum head of 90 ft.

One of the difficulties in connection with the project was to secure a reserve reservoir at the proper elevation and near the city. A suitable site was finally located on the Humpback Road, about 10¾ miles from Fountain Square in Victoria. This reservoir covers an area of about 40 acres, from which it was first necessary to clear a thick forest. The earth on the reservoir site is a black soil of a peaty nature, and it is proposed to cover this with a 6-in. layer of clean sand and gravel, to act as a diaphragm between the soil and the stored water.

Test pits were excavated on the site proposed for the dam and satisfactory rock foundation found. In the deepest part this was about 30 ft. below the valley floor. A concrete dam was planned here and is so located that with a maximum height of 60 ft. and a crest length of 600 ft. it impounds 136,000,000 imp. gal. The dam contains about 8000 cu. yd. of masonry.

A gate house with control valves and screens was provided at the dam and two cast-iron outlet pipes 34 in. in diameter were installed for delivery to the pressure mains, while a 16-in. cast-iron pipe will be used to discharge waste water.

On reaching the Humpback reservoir the water from the gravity-flow line will pass over a weir into a concrete chamber, from which there will be an outlet either by flowing over a stepped cascade, over concrete and rock into the reservoir (for aëration) or by a pipe with a submerged outlet, controlled by a butterfly valve. The pipe will taper from a 36-in. diameter to a 24-in. diameter in 20 ft. and will be used if there is a tendency for the water to churn milky due to microscopic growths.

RIVETED STEEL PIPE

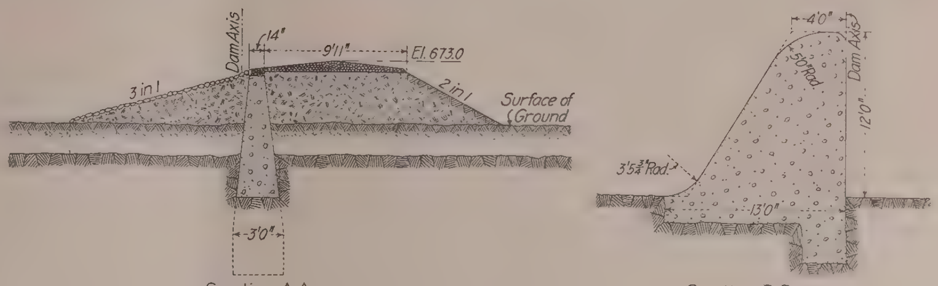
It is proposed to deliver the water from the Humpback reservoir to the city through a 36-in. riveted steel pipe. Delivery could not be made from the pipe direct to the city service system, as the pressure would be too great, so the water is allowed to overflow into Smiths Hill reservoir as a stand pipe. This is situated at the southern city limits at an elevation of 167 ft. below the water level of Humpback reservoir, or 213 ft. above sea level, while the average elevation of the city is, roughly, about 50 ft. above sea level. The elevation of Humpback reservoir will enable it to deliver later directly into the city's high-level system, which has to be served at present by pumping.

A consideration of tenders on riveted steel pipe and lock bar pipe for this pressure line resulted in a decision to use the former. There will be two thicknesses of plate—20,500 lin. ft. of pipe using plates 5/16 in. in thickness and 36,500 lin. ft. of pipe using ⅜-in. plates. This plate will be made by the open-hearth process, and the rivets are to be extra-soft steel, according to the requirements of the American Society for Testing Materials. The pipe is to be made in four-plate lengths, which will give sections about 22 ft. long. Each pipe is to be dipped in a hot bath (400 deg. Fahr.) of Pioneer mineral pipe coating, bitumastic, or their equal. Inside and outside courses are to be used. The riveting and spacing of rivets must produce a 70 per cent joint. All rivets are to be driven by pneumatic or hydraulic-pressure machines in the shop and pneumatic hammers in the field. No angle will be permitted in any joint of the pipe line of more than 3 deg.

There are to be four concrete gate houses located along the line, with 36-in. rising-stem gate valves; 6-in. nozzles will be riveted to the pipe for the 6-in. gate valves which are placed at the bottom of all dips for emptying the pipe. Inlet and outlet air valves will be similarly attached to 4-in. nozzles on top of the pipe, the former to prevent collapse and the latter to prevent air binding at the summits. A Venturi meter with a recording apparatus will be installed in a concrete house a short distance below the Humpback dam, with which an accurate record is to be kept of the water passing through the pressure main.

A contract for the construction of the entire work was made with the Westholme Lumber Company, of Victoria, in January, 1912, but this contract was abandoned by the company in April, 1913, and since then the city has proceeded with the project both by day labor and by subcontract. A contract for the 27.3-mile gravity-flow line was recently awarded to the Pacific Lock Joint Pipe Company, of Seattle, Wash.

Wynne Meredith, of the firm of Sanderson & Porter, of New York City and San Francisco, was retained in July, 1911, as the consulting engineer for the city's water commissioner. Boyd Ehle is the present resident engineer at Victoria. James H. Raymur, as water commissioner, was the executive of the city of Victoria in charge of the project during the preliminary stages, and was succeeded early in 1913 by Charles H. Rust.

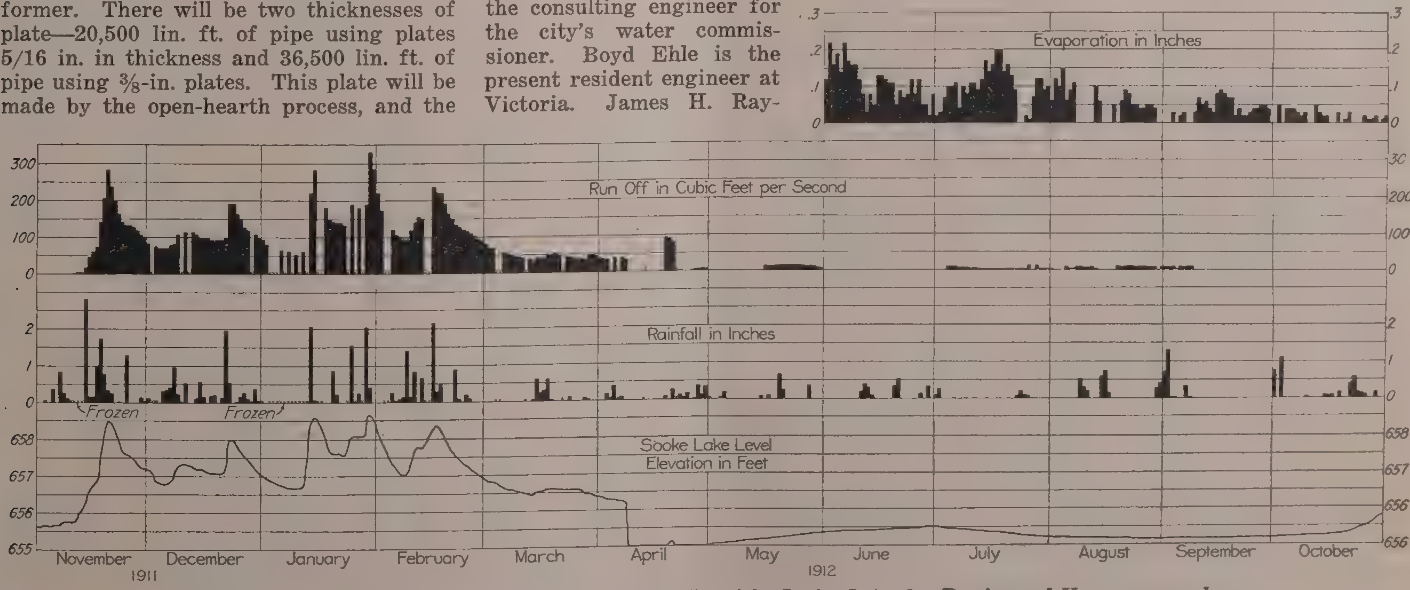


Section A-A Section B-B

Earthfill and Concrete Ogee Sections of Dam (See Plan, Page 225)

Vigiljoch Rope Railway in Switzerland

THE summit of the Vigiljoch Mountain in Switzerland has been recently made accessible by the installation of a wire line in two sections, worked electrically. The length along the slope is 7216 ft. and the vertical height, 3782 ft., the longest span being 656 ft. horizontally. Particulars are given in a recent number of "Le Genie Civil," of Paris. The supporting columns are pyramidal in form and of latticed steel, a cross-arm being fixed at the top to carry the supporting or "track" ropes, while cast-steel swinging shoes are used for these to rest in. The "track" ropes are 13 ft. 1 in. apart. In addition to these, and those used for hauling, are guide-ropes and brake cables, the latter being necessary owing to the fact that any brake gripping the "track" cables must come foul of the supports when passing. The brake cable, which is exactly like the traction cable, remains normally at rest, but the application of the brake is effected by gripping this firmly when the cable is put in motion, and the braking is done by drums in the upper stations. The 2.36-in. "track" cables have a total braking stress of about 594,000 lb. The traction and brake ropes are of half the diameter of these, and guide cables are provided to check oscillation. There are two cars for each section, with a capacity of 14 passengers each, one traveling up as the other is coming down. A tail rope is provided for each car so as to further equalize the load.



Curves of Evaporation, Runoff, Rainfall, and Water Level in Sooke Lake for Portions of Years 1911 and 1912

Boston Foundations

Abstract of Paper Presented by J. R. Worcester to the Boston Society of Civil Engineers

GEOLOGICAL conditions in the city of Boston, where the ground consists largely "of clay, free from grit but containing a large proportion of quartz flour, with thin layers and streaks of very fine sand and occasional angular fragments of rock," were discussed by J. R. Worcester in a paper presented recently to the Boston Society of Civil Engineers. In some places there are thick strata of clay and gravel and of hard boulder clay. Some of the material is very soft clay and some of it is silt having a similar appearance. It is nearly impervious to water, is soft and smooth and very hard when dry. It is compressible and generally underlaid with peat. These conditions make it unsafe for supporting foundations.

SINKING OF FLOORS

Where basement floors have been laid directly on soft ground and the wall foundations have been built on piles the middle of the floor sunk in numerous cases from 6 to 12 in. In other cases the floors have been raised by the action of hydrostatic pressure. Mr. Worcester has assumed that in floors supported directly on the surface of the wet ground, only 50 per cent. of the area is exposed to hydrostatic pressure, an assumption that has so far proved adequate for designing purposes.

Numerous foundations have been constructed in open circular wells sheeted with vertical planks bearing against inside steel rings. In other cases holes 3 ft. in diameter have been sheeted with metal forms, removed as the concrete was placed. In some cases where little difficulty was encountered from water efficient and economical results have been obtained by expanding the bottoms of the holes.

Mr. Worcester recommends testing the bearing capacity of soil by means of a load applied to a plunger set in a small, accurately excavated hole in the bottom of a pit dug nearly to foundation elevation. Tables of soil tests and of tests of the bearing values and settlements of piles are given.

RECORD OF BORINGS

The paper is followed by an appendix containing sectional maps of the city, giving the location of borings, and record sheets where the different strata are indicated by conventional figures. The figures are classified in different groups, each group beginning at a 100 point, with different combinations of the same character of material or variations of it indicated by the unit and with extensions above 100 shown by prefixing a thousand figure. Thus different blue-clay combinations are indicated by numerals from 100 to 199 inclusive, beyond which additional samples are identified by numbers 1101 to 1199 and 2100 to 2109 inclusive. Yellow-clay combinations are indicated by numbers 200 to 265. Sand combinations are 300 to 399 and 1300 to 3323; gravel combinations, 400 to 466; silt combinations, 500 to 569; mud combinations, 600 to 667; stone or rock combinations, 700 to 739; filling combinations, 800 to 805; hardpan, 900; and wood, 1000.

A summary of recommendations follows:

1. In designing foundations, preliminary borings are of great value to assist in determining: (a) At what lever, if at all, firm soil may be reached; (b) whether piles are likely to be an advantage, and if so, about how long they will probably be; (c) in case a hard crust is encountered, its thickness, and the nature of the underlying material.
2. It is of great importance to support all parts of structures on a stratum of soil below the silt and peat.
3. The maximum and minimum levels of the ground water should be determined—the maximum to obtain the hydrostatic head on waterproofed basements and the minimum to determine a safe level for cutting wooden piles.
4. As tentative suggestions for safe bearing pressures on soil the following are proposed: Dry, hard, yellow clay, "boulder clay," dry sand or gravel, 6 tons per square foot; compact, damp sand, hard sandy clay, hard blue clay, 5 tons per square foot; medium blue clay, whether or not mixed with fine sand, 3½ tons per square foot; soft clay, running sand (confined), 2½ tons per square foot.
5. For the safe supporting power of piles, the formula $P = 3Wh/(p+1)$, where $P =$ supporting power in pounds; $W =$ weight of hammer in pounds; $h =$ fall of hammer in feet; $p =$ penetration in inches.

Federal Evaluation of Railroads

Charles A. Prouty Discusses Methods of Procedure, the Time and Expense Involved and Some of the Benefits to Be Derived

UNDER three heads—the thing to be done, the time and expense required and the benefit to be derived—Charles A. Prouty, director of evaluation of common carriers recently begun by the Interstate Commerce Commission, discussed the valuation of railroads at the annual meeting last week of the Chamber of Commerce of the United States of America. Mr. Prouty emphasized the fact that the valuation is not merely an engineering task but that it is also a social, economic, legal and political problem, the solution of which requires all information obtainable as to condition and history of the railways. He thinks that it is likely to take more than six years and cost $12,000,000 to complete the work, but that the benefits will dwarf the cost. These notes are taken from his address.

THINGS TO BE DONE

Most people probably understand that the cost of reproduction, with or without depreciation, determines the value of the railway, so that, having ascertained and reported these facts, the duty of the commission has been discharged. This is by no means true. Many other things have been enumerated by the U. S. Supreme Court as bearing upon the value of the property. The valuation act itself requires the commission to ascertain the cost of construction, the amount of money which has been invested and the sources from which that money has been derived; to give, in short, a complete corporate and financial history of these properties; to take note of the earnings of the property, and having all these facts before it to determine from a just consideration what is the value of the property itself. To state the value of the property many difficult questions may be encountered.

EXPERIMENTAL OUTLAY

The first railroad which the commission is proceeding to survey in the Pacific District is the San Pedro, Los Angeles & Salt Lake. Most of this road has been built in comparatively recent times, and the circumstances and cost of construction are fairly well known. A section of it was located where no man thought it could ever be disturbed by floods, yet shortly after it was opened for operation floods came and carried out this portion. It was at once reconstructed upon a new location supposed to be beyond all possible danger from a recurrence of the previous disaster, but the waters again came and washed away this same section. Then it was rebuilt upon a third location, beyond all possible reach of future trouble from this source.

Considering the nature of the road and the people interested in its construction, it seems probable that due caution was exercised in the original location. It is undoubtedly true that the second location was made with great care, and was believed to be beyond possible danger. It has cost a large sum more to rebuild this road than it would have originally cost to construct it where it is to-day. Now in determining the value of this property what if any allowance is to be made for this experimental outlay? If the government itself had constructed this railroad it probably would have had the same experience and would have expended the same amount of money which the owners actually did.

The same idea enters more or less into the valuation of most of the railroads of this country. There has of necessity been a certain amount of experiment before hitting on the right thing. Does this development expense constitute an element of value which may be recognized to-day, or must the owners of these public utilities stand the loss of their mistakes in the same way that the owner of a private enterprise would? Vast sums of money are involved in the answer to that very simple question.

UNEARNED INCREMENT

Some years ago in a case pending before the commission the Northern Pacific Railway had occasion to prove the value of its property, and did so by showing the cost of reproduction. Among other things it showed the amount of land upon which its right-of-way was located and what it would cost to acquire that land for railroad purposes at that time, claiming that this cost of reproduction was the value of its property. The Northern Pacific runs through the city of Spokane. When the road was built that city was of small account, but it has grown up on both sides of this railroad. The Northern Pacific claimed that the cost of acquiring its right-of-way through the heart of the city of Spokane at the time of the hearing would be at least $5,000,000. The original cost to the railroad was nothing, the right-of-way having been entirely donated either by the Government or by private benefaction. Now to whom belongs this $5,000,000? Has the Northern Pacific the right to tax the public for a return upon that amount? This question of the unearned increment presents a difficult problem.

Illustrations like these emphasize the fact that this valuation is not a mere engineering problem, involving the cost of reproduction or the amount of depreciation alone. It is for the commission to marshal every fact obtainable with respect to the present condition and the past history of our railways, and from a just consideration of all these facts to determine the fair value of the properties to-day.

TIME AND EXPENSE

Surveys began in all the five valuation districts except one about Feb. 1, and will begin in that district about Feb. 15. A railroad has been selected in each district upon which these surveys will proceed with deliberation and in such manner as to afford a kind of instruction school to all employees. This preliminary work will occupy three or four months. Beginning about July 1 the force can be rapidly increased.

The field surveys ought to be concluded in from four to six years from July 1. It is hoped that the accounting and other work will keep pace with the field surveys. The putting together of these facts, that is, the actual valuation, will necessarily lag somewhat behind the obtaining of the facts themselves. The commission will in the near future have all the data with respect to some railroads, but whether a valuation will be at once announced in such cases must depend upon the method which the commission selects for determining the various questions which will arise.

Railroads have been valued both by public authority and by themselves, and the cost of these valuations has run all the way from $2 to $75 per mile. Judging from the experience of State commissions, $15 per mile would be sufficient to cover the engineering part of the work, and $10 per mile the accounting and other features. This would aggregate for the entire 250,000 miles between $6,000,000 and $7,000,000. If the experience of railroads be consulted an entirely different conclusion is reached. The cost, as reported, of valuations conducted by the carriers themselves runs from $40 to $80 per mile. In this work by the railways certain things are included which will not be done by the commission, but to offset this most carriers have ascertained simply the cost of reproduction, with no reference to depreciation, and with but little accounting work. If this information is correct and if the Government cannot do this work cheaper than the railroads themselves, it will cost at least $50 a mile or $12,000,000 in all to complete the work.

While this is a large sum, it is the merest trifle compared to the enormous values involved. The capitalization of our railroads at the present time aggregates nearly $20,000,000,000, and it has been recently estimated that these securities at their present market value are worth from $14,000,000,000 to $15,000,000,000. The cost of this work, therefore, cannot exceed from one-tenth to one-twentieth of 1 per cent of the value ascertained, a sum utterly insignificant in proportion to the magnitude of the thing dealt with.

BENEFIT

What, finally, is the purpose of and the benefit to be derived from all this outlay of money and of energy? There are many advantages, some of which are referred to without thereby intending to minimize the others.

The investor is a necessary part of the well-balanced state, and is often in need of protection from public authority. It is the duty of the Government within reasonable limits to see to it that the would-be investor is not hoodwinked in the making of his investment and that the value of his investment, when once made, is not improperly destroyed. In railway investment the public has a more immediate interest. Just in proportion as railway securities commend themselves to the investing public it is possible for the railway to obtain the money with which to make necessary improvements to its property. Whatever benefits the credit of railways indirectly reduces the cost of furnishing railway service and thereby inures to the benefit of the general public. Now when any investor can know from reliable sources the exact character of his investment; how much it would cost to reproduce the property; in what state of efficiency that property is being maintained; above all, what is the value of that property for use as a railroad, there has been injected into railroad securities an element of certainty and of permanency which does not now exist.

Under the constitution as interpreted by the United States Supreme Court the property of public utilities must be allowed a fair return upon the fair value of the investment. What is a fair rate of return depends, probably, to some extent upon the character of the property and its location. The relative functions of the legislative and judicial branches in the fixing of that rate are not yet clearly defined. All just men concede that it should be substantially the same as the return obtainable from private investment having the same incidents. Manifestly it is not a difficult thing to determine the rate of return to which this property is entitled. There still remains, however, the value upon which this rate is to be computed, and until that value is known it is impossible to determine what total income the property is entitled to earn and, therefore, to fix the charge which may be justly made against the public.

INTERDEPENDENCE OF RATES

It is, perhaps, the natural inference that when the value of the property has been determined and the rate of return fixed the work of the commission in establishing the charge of the public utility is comparatively easy; that it is only necessary to multiply the value by the rate and to allow a charge which will yield that income. Seldom, however, can a single railroad be considered by itself. The greater part of the business of the railways of the United States is subject to competitive conditions of one sort and another which are largely controlling so that the rates of one are necessarily bound up with those of another. While two given points may each be served by but two railways a great variety of routes between those points can be found by choosing different intermediate carriers, and whatever charge is made over one route must be made by all.

Often where the service is purely local and can only be rendered by one railroad the rate which must be applied is dictated by competitive conditions. A coal mine may be served by a single carrier, but that carrier cannot therefore impose whatever rate it sees fit upon the product of that mine, for, unless the charge to the point of consummation is as favorable as that from some competing mine by some other carrier, the mine itself cannot do business and the railway loses the traffic. This sort of competition is of universal application and of tremendous influence.

ONE RATE MAY FIX ALL

Without further pursuing this subject, which of itself is a broad one, it will be seen that the railroads of this country are so bound up together that their rates are largely interdependent. It is impossible to shake a single railroad free from every other and fix its charges upon the basis of a fair return upon its fair value as you would in case of a gas or water plant. The rate established for one of necessity influences and frequently absolutely determines the rate of all.

Now, if the commission should select that road most advantageously situated, that road whose business is the largest and upon which the conditions of operation are the most favorable, and should so adjust its rates as to yield a return of 6 per cent upon its value, every other railroad standing in competition with it would receive less than 6 per cent and some might receive nothing whatever. On the other hand, if that road laboring under the greatest disadvantage were to be selected and such rates established as would permit it to make a return of 6 per cent upon its investment, its competitors would one and all be receiving an undue return upon their investment.

While the problem of establishing railway rates will not be solved by this valuation, it will be enormously simplified. It can be known with certainty whether the general level of rates is or is not too high, and in establishing the charges to be observed by a single carrier, even in fixing the rate upon a single commodity, it will be of much benefit to know the value of the property involved.

POLITICAL BENEFIT

While this valuation will be of incidental benefit to the investor, and is essential to the work of the rate-making tribunal, it seems to me that its greatest immediate value is political. The state of the public mind towards our railways is such that this information is absolutely necessary. There has come to be a deep-seated conviction in the minds of many people that our railroads as a whole are enormously overcapitalized and that the public is paying interest and dividends upon securities which represent no actual value. On the other hand, it appeared in the Eastern rate advance case, decided in 1910, that the Pennsylvania Railroad had in the ten years preceding that investigation put into its properties east of Pittsburgh more than $200,000,000 from earnings, which, therefore, was not represented in the capital account of that company. It is well known that many other railroads have improved their property out of earnings without any corresponding increase in their capital accounts. This leads many to the conviction that while individual railroads may be over-capitalized our railroads as a whole are worth more than their stocks and bonds.

This is the question which arises before the student of this railway problem at every angle. This is the question which must be answered before the problem can be intelligently discussed. For this reason, above all, it is important that this valuation work should be pressed to a completion in the most expeditious and the most trustworthy manner possible.

Times Square Subway Station in New York

Alternative Designs Proposed for Stations at the Intersection of Old and New Lines at Broadway and Forty-Second Street

THE construction in New York City of the new subway lines approved by the Public Service Commission, and already partly under contract, will create at and near the intersection of Broadway and Forty-second Street a junction of four lines—namely, the Brooklyn Rapid Transit line on Broadway, the Interborough line on Seventh Avenue, and the connections on Forty-second Street with the Steinway tunnels and with the east side line by shuttle trains. The physical conditions and operating requirements necessitate the construction of these lines at varying underground levels at the point of intersection and the requirements of traffic demand provision for transfers between the lines.

The intersection is in the heart of a densely populated hotel and theater district, where a large number of passengers take and leave the trains and where there is great congestion of surface traffic. Both surface and subway traffic are rapidly increasing, and the necessity of relieving the surface congestion and providing safe and convenient access to the subway, and transfers between its different lines, is a very difficult and important problems, which, at best, involves expensive and somewhat elaborate construction. For its solution several different arrangements of underground platforms, connecting passages and depressed tracks have been proposed.

General Arrangement of Tracks

Below Ninety-sixth Street the present subway system has a four-track line running south under Broadway to Forty-second Street, then east under Forty-second Street to Fourth Avenue and then south to City Hall, with a two-track line to South Ferry and Brooklyn. It is proposed to supplement this system by additional north and south tracks connected to the old track so as to make one independent four-track east side line and one independent four-track west side line, connected by shuttle service at Forty-second Street, which may, however, permit the routing, if necessary, of through trains from the east to the west side, or the reverse, in case of emergency. Provision will also be made on Forty-second Street at Broadway and Seventh Avenue for connection by transfers of all these lines with the Steinway tunnel to Long Island, and possibly with the proposed tunnel commencing at the west side of Seventh Avenue and under Forty-second Street and the Hudson River to New Jersey.

The Interborough system will be developed from the present by the construction of a new four-track line on Lexington Avenue north from Forty-second Street, continuous with the existing line on Park Avenue south of Forty-second Street, and by the construction of a new four-track subway on Seventh Avenue south from Forty-second Street, or continuous with the existing line on Broadway. In addition there will be the new Broadway line of the Brooklyn Rapid Transit system (Municipal Railway Corporation), which will pass under Forty-second Street and the east side of Times Square, forming a four-track line up Seventh Avenue to Fifty-seventh Street, and continuing as a two-track line to and east across Fifty-ninth Street to Queens. This line will necessarily be depressed passing under the present Interborough tracks between Forty-second and Forty-third streets.

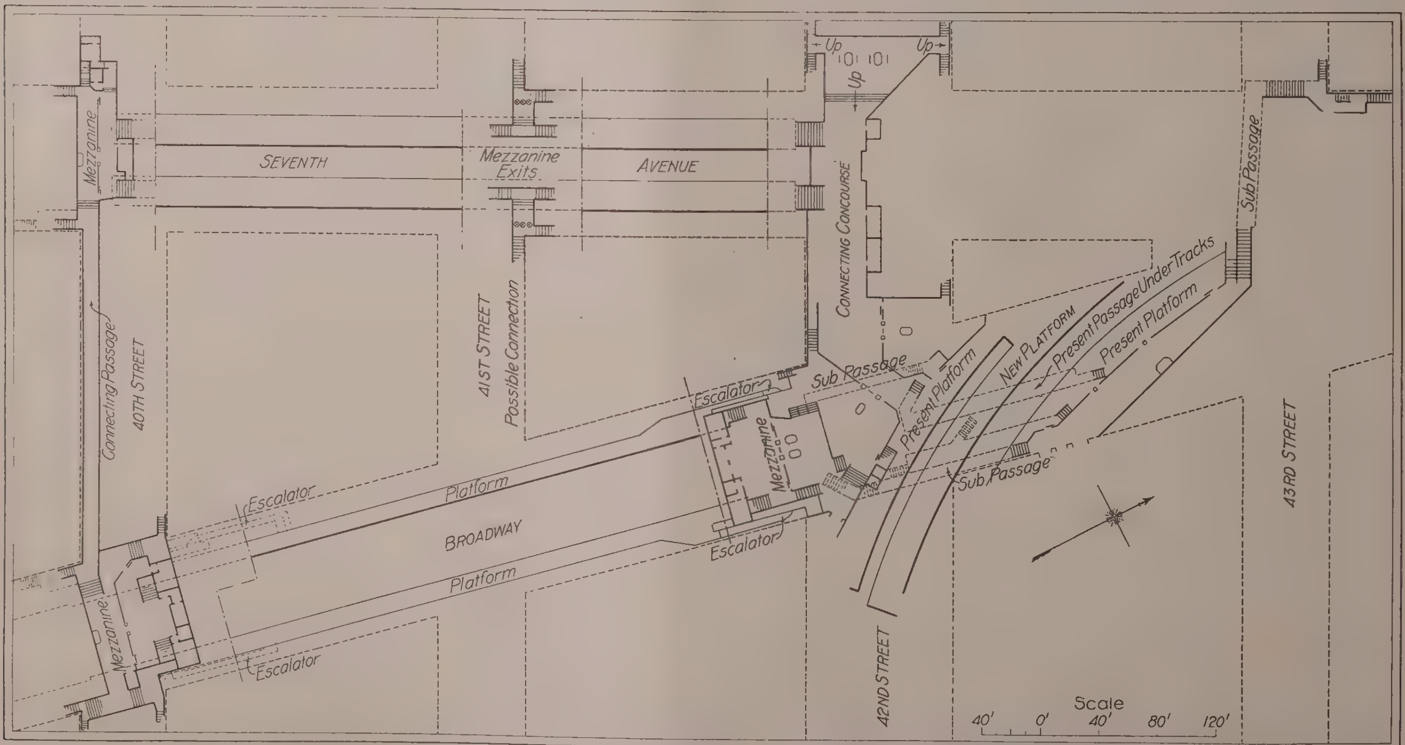
The present system has the Times Square local station on Broadway with exits at Forty-second and Forty-third streets, with the nearest express stations at Grand Central Station on Forty-second Street and at Seventy-second Street on Broadway. The different plans for the proposed Times Square station provide for the essentials outlined and differ in the connections between the different lines and the arrangement of platforms, location of stations and entrances, grades of tracks and routing of trains.

Official Plans

In the summer of 1912, when the dual system of subways was under consideration (see Engineering Record of Sept. 10, 1910, page 289), the connections of the different lines, their operation, and the location and arrangement of the stations at and near Times Square were thoroughly investigated by the engineering department of the Public Service Commission. After numerous studies and public hearings of interested parties on Broadway and elsewhere the design was adopted that was intended to secure the best combination of economy in construction, safety and efficiency of operation and convenience of passengers. Complete designs have been prepared for this arrangement and are now practically ready for the award of contracts.

These designs provide for express stations at Thirty-fourth and Forty-second streets on both the Seventh Avenue and the Brooklyn Rapid Transit Broadway lines, for an express station at Fifty-ninth Street and a local station at Forty-seventh Street on the Brooklyn Rapid Transit Broadway line, for a regular shuttle service on Forty-second Street between Broadway and Park Avenue (Grand Central Station), and for a terminal station at Forty-second Street and Broadway for the Steinway tunnel service going east from Broadway under the East River to the Borough of Queens, with ample mezzanine and transfer facilities between all these stations. In providing for the Steinway service there will necessarily be a depression of two of the present tracks on Forty-second Street somewhere between Broadway and Park Avenue, in order to connect with the Steinway tunnel at present constructed from Park Avenue to and across the East River.

In considering the connection between



Official Plan for Times Square Station, Showing Track Platforms, Mezzanine over Main Tracks and Entrances and Exits

Park Avenue and Lexington Avenue, provisions have been made for a possible routing of some of the local trains across Forty-second Street to Times Square, and the tracks are so adjusted as to avoid grade crossings where they diverge from Park Avenue into Forty-second Street. It is thought that in the evening, after the rush-hour service on the main trunk is over, certain trains can then be run from Park Avenue over to Times Square, serving the theater district during the evening hours without interfering with the somewhat reduced train operation from Lexington and Park avenues after the rush-hour period is passed. It may be here noted that the routing of these trains from Park Avenue across Forty-second Street can be continued in case of necessity during any period of the day up the Broadway west-side line, but this would be done only in case of an emergency.

STATION ARRANGEMENT

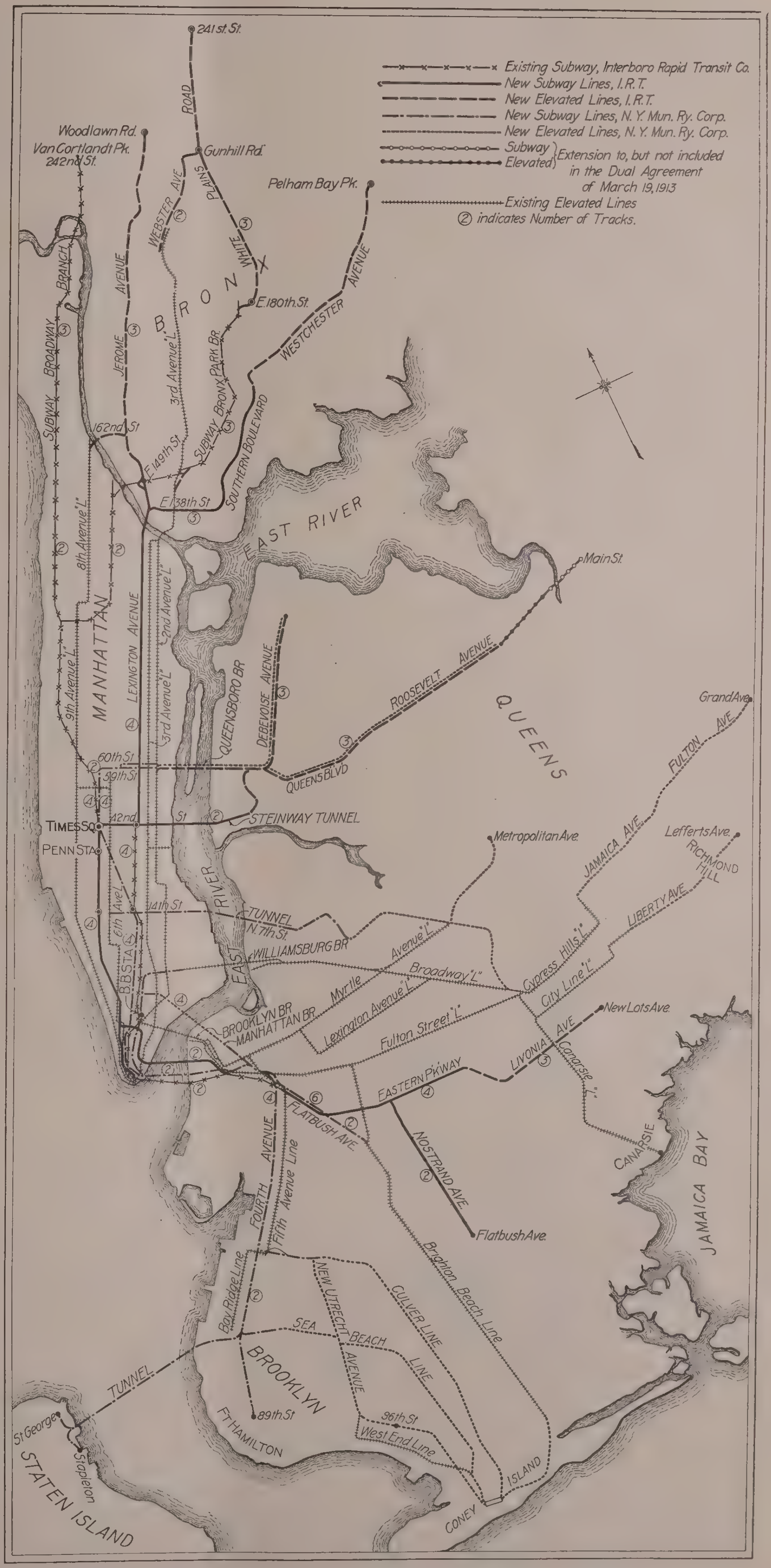
The station arrangement retains the present platforms and entrances on Broadway at Forty-second and Forty-third streets, which will directly serve the local traffic on the Broadway lines and the traffic from the Steinway tunnel tubes and the Forty-second Street shuttle trains, all at the present platform level, which is as near as possible to the surface. This station will be extended on Broadway south of Forty-second Street, with additional entrances on Broadway by stairways and escalators to a platform at the same level as the present, which will be extended one-half the width of Forty-second Street in the line of that street to the west side of Seventh Avenue, forming a concourse about 36 ft. wide with entrances on Forty-second Street, west of Seventh Avenue, as well as entrances on both sides of Forty-second Street between Broadway and Seventh Avenue.

Across Seventh Avenue this concourse will form a mezzanine over the Seventh Avenue tracks, which will be reached by stairways descending to platforms extending to Fortieth Street, with entrances from the street level there and at Forty-first Street on both sides of Seventh Avenue. The Fortieth Street end of the platform may be connected with the end of the passenger platform for the Broadway tracks at a lower level by an underground passage through Fortieth Street at the same elevation as the mezzanine floor on the Forty-second Street tracks. Another passage may be constructed if found necessary and practicable to connect the Broadway and Seventh Avenue paltforms below the surface of Forty-first Street.

PLATFORMS TWO BLOCKS LONG

On account of important construction and operation considerations all new station construction will be located south of Forty-second Street. It provides track platforms two blocks long both on Broadway and Seventh Avenue, with direct communication between them and to the street at both ends, and with communication at the Forty-second Street end with the east side, and proposed Long Island lines, which necessitate only a very short walk and the ascent or descent of a single flight in going from any train to any other train.

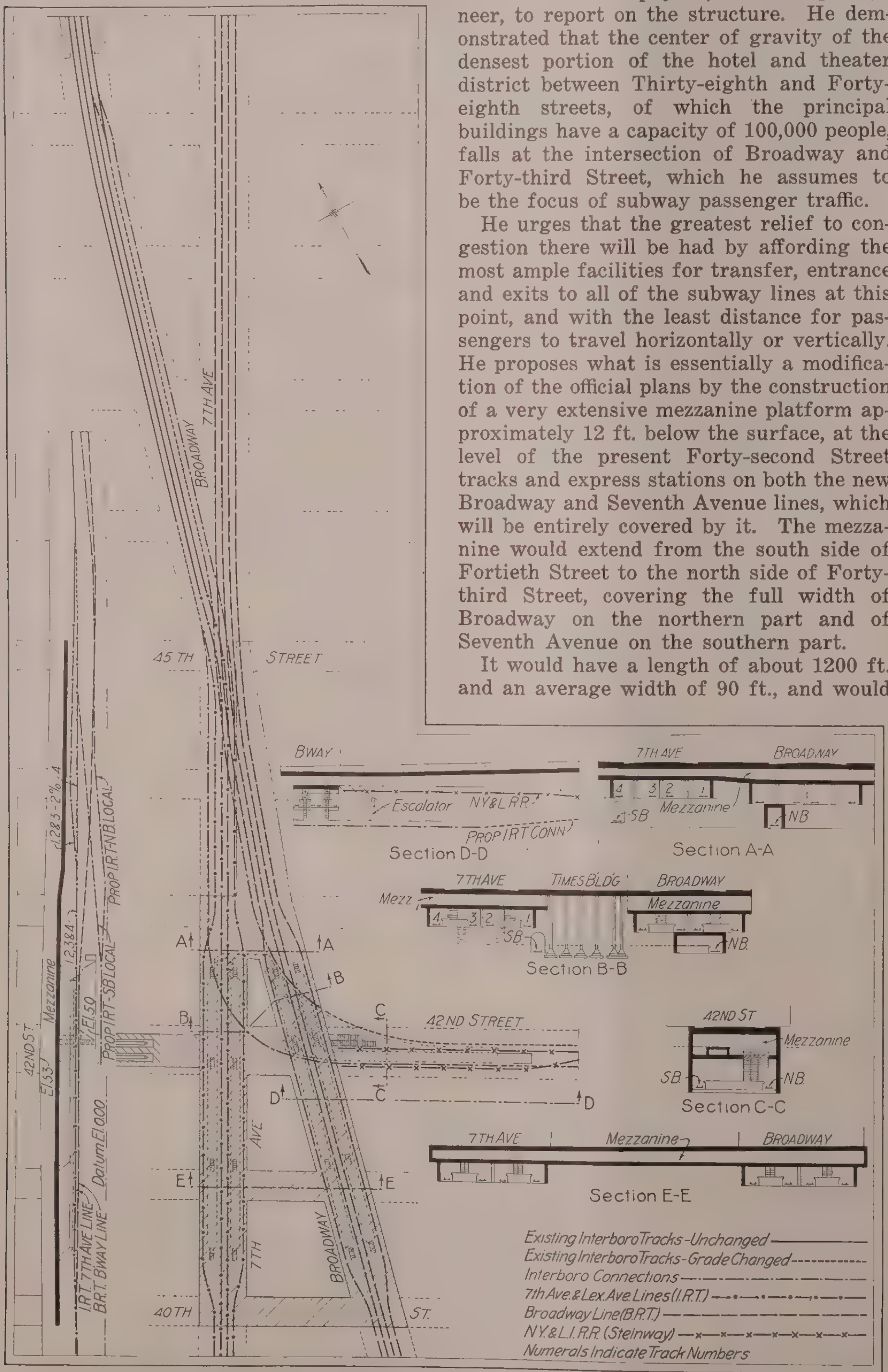
It does not involve very deep or wide excavation or superfluous and dangerous undercutting of the existing structure under very heavy traffic. It does not entail



Complete Plan of Present and Authorized Subway and Elevated Lines in Greater New York cost in excess of the necessary requirements of the individual lines, nor any depression of tracks other than is required for the passage of the Broadway line under the present Interborough tracks at Times Square.

It is designed to provide for a system of train routing that will be simple and direct and will develop the maximum capacity of the subway, and it not only provides subsurface communication with the different lines, but also permits a considerable amount of under-street crossing at a very congested point to avoid the danger and interruption from the vehicular traffic.

This scheme, it is believed, does not involve any serious structural difficulty in the location of an express station on the Broadway line between Fortieth and Forty-second Streets, but the desirability of constructing such a station is now considered doubtful.



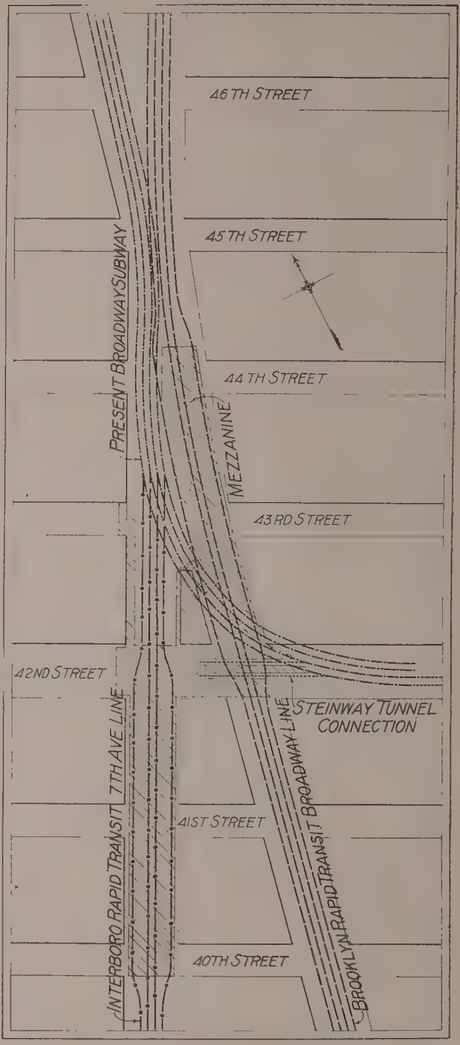
Harwood Plan for Depressed Connection between Forty-second Street and Seventh Avenue Tracks

The vital element of the operating scheme is the routing of through service in the Broadway and Seventh Avenue lines at the rate of forty trains per hour on each track, which is believed to be about the ultimate maximum capacity of the subway and will require an uninterrupted uniformity and equality of movement on the old and new portions of the Broadway line on the west side and the old and new portions of the system on the east side.

Opdycke Plan

A number of large real-estate owners in the vicinity of Forty-second Street and Broadway considered that the official plans here outlined do not provide adequately for the best interests of this locality and retained H. C. Opdycke, consulting engineer, to report on the structure. He demonstrated that the center of gravity of the densest portion of the hotel and theater district between Thirty-eighth and Forty-eighth streets, of which the principal buildings have a capacity of 100,000 people, falls at the intersection of Broadway and Forty-third Street, which he assumes to be the focus of subway passenger traffic.

He urges that the greatest relief to congestion there will be had by affording the most ample facilities for transfer, entrance and exits to all of the subway lines at this point, and with the least distance for passengers to travel horizontally or vertically. He proposes what is essentially a modification of the official plans by the construction of a very extensive mezzanine platform approximately 12 ft. below the surface, at the level of the present Forty-second Street tracks and express stations on both the new Broadway and Seventh Avenue lines, which will be entirely covered by it. The mezzanine would extend from the south side of Fortieth Street to the north side of Forty-third Street, covering the full width of Broadway on the northern part and of Seventh Avenue on the southern part.



Opdycke Plan for Extended Mezzanine

It would have a length of about 1200 ft. and an average width of 90 ft., and would serve as a common concourse for passengers on all trains, affording transfer from any line to any other line and distributing passengers to numerous exits that would enable them to reach any point on either side of Broadway or Seventh Avenue between Fortieth and Forty-third streets without the danger and delay of passing through the congested surface traffic.

The present physical connections between two of the Forty-second Street tracks and two of the upper Broadway tracks would be maintained, but a portion of the tracks would be covered by a section of the mezzanine platform, creating a dead end for the shuttle-train service. (This same provision was contemplated in the Public Service Commission's plans.) This section of the platform would be made vertically movable, so that in case of emergency or other necessity it could very quickly be displaced, affording opportunity for the operation of trains between Forty-second Street and upper Broadway.

Harwood Plan

It is computed that about 18,000,000 passengers annually enter and leave the Grand Central Terminal of the New York Central & Hudson River Railroad at Forty-second Street and Park Avenue by way of the subway from upper Broadway and Forty-second Street. Chiefly in order to provide through service for them without the necessity of changing at Times Square, another station plan has been proposed by George A. Harwood, chief engineer of the electric zone improvements of the New York Central & Hudson River Railroad Company.

He advocates the construction of a mezzanine at present track level about 12 ft. below the surface, extending from Fortieth to Forty-fifth Street and occupying the full width of Broadway and Seventh Avenue on the intersecting cross-streets for that distance, except on Seventh Avenue from Forty-third to Forty-fifth Street. Besides this, the mezzanine has extensions of several hundred feet under Forty-second Street on both sides of Broadway to provide tracks for the shuttle and Steinway tunnel service on the east and for the proposed McAdoo line to Jersey on the west. Express stations are proposed at Forty-second Street for both the Broadway and Seventh Avenue lines.

The distinctive feature of this scheme is the uninterrupted mezzanine providing connection between the east and west side subways for both north and south-bound trains. Passengers desiring to take any subway train can enter at any convenient point on Broadway or Seventh Avenue. This mezzanine will also form a valuable addition to Times Square, enabling pedestrians to cross Broadway, Seventh Avenue and Forty-second Street without interfering with the vehicular traffic on these streets. It further provides for train service from the upper west side down Park Avenue without change of cars. If this connection is not built all these passengers will have to transfer at Times Square.

Two tracks of the present Forty-second Street line would commence to descend from their present grade at a point just west of Fifth Avenue and would cross under the new Broadway and Seventh Avenue lines at Forty-second Street, where they would curve north, passing on both sides of the Times Building and rising to make physical connections with the present Broadway line at about Forty-fifth and Forty-eighth streets. They would be provided with a local station at Broadway and Forty-second Street, and the stations for the other lines would be arranged as previously described.

By flattening the descending grade of the Interborough Forty-second Street line and the ascending grade from the Steinway tunnel at their point of intersection on Forty-second Street between Fifth and Sixth avenues it would be possible to introduce crossovers, so that the train service in Forty-second Street could be supplemented by a separate service to handle business coming from the south and Broadway and Seventh Avenue, which would leave Times Square at the level of the mezzanine floor and the Steinway tracks and arrive at the Grand Central Terminal Station on the tracks at the level of the present platform. This plan involves the construction of about 200,000 sq. ft. of mezzanine floor having a very heavy traffic, and involves an important change in the position of the established Interborough tracks in the present subway, which must be maintained in operation during new construction.

At Big Eddy in the Columbia River 536,000 hp can be developed for eight months in the year, or 300,000 hp continuously, according to a report by John H. Lewis, State engineer of Oregon. It is estimated that the plant will cost $77 per horsepower.

Results of Sewage Treatment at Columbus, Ohio

Performance of Tanks and Sprinkling Filters in 1913 as Discussed in Annual Report of C. B. Hoover, Chemist in Charge

PREVENTING offensive conditions in the Scioto River below the Columbus (Ohio) disposal works was more difficult of attainment in 1913 than in any year since the plant was installed, according to C. B. Hoover, chemist in charge, in the last annual report, a summary of which follows. A full description of the plant appeared in the Engineering Record on Dec. 30, 1905, and the 1910 results were reviewed in the issue of Jan. 6, 1912.

This 10-acre plant was in service in 1913 222 days and treated an average of 15,560,000 gal. daily. The average time the septic tanks were in continuous service was 36 days and the storage period was four hours. Of 300 parts per million of suspended matter 60 per cent was removed in the tanks, while there was a reduction of 29 per cent from the 147 parts of dissolved oxygen consumed in the original sewage.

Sprinkling Filters

The sprinkling filters worked 13.15 hours per day at a rate of 2,850,000 gal. per day. Suspended matter was reduced from 121 to 63 parts per million, and dissolved oxygen consumed from 104 to 26. In the effluent there were 4.55 parts of nitrogen as nitrites and nitrates, 4.87 parts of dissolved oxygen and 60 per cent for stability value.

In the final sedimentation basin where the liquor remained 3.1 hours, suspended matter was reduced from 65 to 50 parts, dissolved oxygen consumed from 27 to 22 parts, and nitrogen from 4.8 to 4.0. The mean value of the dissolved oxygen lost in the basin was from 4.87 to 2.36 parts, but after passing the outlet weir the effluent recouped oxygen to a value of 4.54 parts per million.

From May 1, 1913, to Jan. 1, 1914, the mean daily discharge of the Scioto River was between 80 and 100 million gallons and the mean velocity was between 0.2 and 0.3 ft. per second. During this time there was not a single day when scouring velocities prevailed. The mean daily dry flow of sewage during this time was between 20 and 25 million gallons and the average pumpage at the main pumping station was 15.5 million gallons. With insufficient pumping and treatment facilities and insufficient operating funds, we had the impossible task of preventing offensive conditions in the Scioto River below the city. There was a daily discharge of enough raw sewage and trade wastes into the river to more than tax its oxidizing capacity. This wastage of raw sewage will not take place during the coming year unless it is necessitated by a lack of operating funds. The pollution of the river by trade wastes should also be stopped.

Sewage Pumping Stations

The East Side sewage pumping station was in service 55 per cent of the total time and 80 per cent of the time between May 1 and Dec. 31. The average daily pumpage for the time in service was 1.9 million gallons and the total pumpage was 80 million gallons more than in 1912. Offensive conditions did not exist in Alum Creek during the year and for this reason the work of the station was satisfactory. The repairs on the gas engines were high, amounting to 7.4 per cent of the total operating cost and $1.12 per million gallons pumped.

The main sewage pumping station was in service 79.7 per cent of the total time and 97 per cent of the time between April 1 and Dec. 31. The average daily pumpage for the time in service was 15.3 million gallons and the total pumpage was about one-third greater than in 1912. The repairs on the pumping equipment amounted to 6.9 per cent of the total operating cost and the cost of repairs per million gallons pumped was $0.33.

The sand lifting apparatus in the sand catcher of the east side intercepting sewer did very good work and the removal of so much sand and refuse at the sand catcher reduced the wear on the pumps, increased the efficiency of the condensers (sewage is used for cooling), and prolonged the period of uninterupted service by reducing the deposits in the suction wells. The average total lift was 18 ft. and it required an average consumption of 1526 lb. of coal at an average price of $1.73 per ton to lift one million gallons through 1.2 miles of a 48-in. cast-iron force main to the septic tanks at the treatment works.

Sludge Disposal

There was no discharge of sludge from the septic tanks to the river at any time during the year. When the tanks were cleaned, the sludge was flushed by gravity to a large gravel pit adjacent to the works and the moisture content was reduced by percolation through the porous gravelly subsoil and also by evaporation. This sludge did not become offensive enough at any time to create a nuisance. This method of sludge disposal is only temporary and must be abandoned in the near future for permanent sludge drying beds.

The work of the sprinkling filters was satisfactory considering the character of the preliminary treatment and the method of dosing. An unusually large amount (48 per cent of that applied) of suspended matter was retained in the filtering material and this may have been responsible for some of the pooling and also for the feeble nitrification which at times characterized the work of the sprinklers. The removal of suspended matter by the final settling basin was slight (23 per cent) because the sprinkler effluent was low in suspended matter. The improvement of the sprinkler effluent by the basin treatment amounted to 18.5 per cent on the basis of the dissolved oxygen consumed, and 8 per cent with respect to the stability value. The final effluent showed an average saturation of 47 per cent with dissolved oxygen, which was better than the mean value for the river water just above the effluent outfall.

Condition of Scioto River

The Scioto River was seriously polluted throughout the year with raw sewage and trade waste. Foul odors, gasification, and floating sludge were present at times in a zone which extended from the relief outlet of the East Side intercepting sewer to about 15 miles below the effluent outfall of the works. This is the zone in which the rate of the consumption of dissolved oxygen is greater than the rate of absorption of oxygen from the air. The boundaries of this zone are determined by the dilution, the oxygen requirements of the liquor which is discharged into the stream, and the temperature. An effort is being made to correlate the river studies and laboratory tests so that a laboratory method of testing a sewage or sewage works effluent can be worked out which will yield results that will enable one to form an intelligent judgment as to what will happen when such liquor is turned into a stream whose volume of flow and oxygen content are known. Wherever gasification was noted, sludge deposits were found, and odors never were detected where there was any residual dissolved oxygen, although the absence of oxygen was not always accompanied by odors.

A general consideration of the results of river studies and the results of treatment for the year indicates that the prevention of the pollution of the river above the works is the first and most pressing duty and that this should be followed up with the installation of additional and improved treatment facilities.

Maps and Profiles for Federal Valuation of Railroads

Comparison of Specifications Finally Adopted by Interstate Commerce Commission with Tentative Draft Submitted Last Year

THE final specifications for maps and profiles to be furnished by the railroads to the Interstate Commerce Commission in connection with the Federal valuation work have just been issued in the form of a 22-page pamphlet, and are declared effective Feb. 1, 1914. They demand from each steam railway carrier on or before Feb. 1, 1915, unless the carrier be given an extension of time, complete maps and profiles of its property as of June 30, 1914. Similar records of extensions, improvements or changes made after June 30 must be furnished within six months after the change has been put into operation.

In general the commission holds to the demands set forth in the tentative draft first submitted, outlined in the Engineering Record of Sept. 13, 1913, page 292. Tracings of standard size are demanded in all cases, although they may be made by a lithographic process. New maps and profiles must conform strictly to the specifications. The commission states that it does not mean to require the unnecessary construction of maps and profiles, and that those already in existence will be accepted if they are deemed to contain the information in such form that it is reasonably available with or without modifications.

The three forms of tracings originally specified are required—right-of-way and track maps, station maps and profiles. Right-of-way and track maps may be on either a 400-ft. or a 200-ft. scale. Station maps may be either 100-ft. or 50-ft. to the inch, separate drawings for lands and for tracks and structures to be furnished where clearness requires. There must be separate profiles with alignment diagrams, 400 ft. per inch horizontally and 20 ft. per inch vertically. All tracings must be 56 in. long; maps must be 24 in. and profiles 12 in. wide. Specimens of each type are appended to the specifications.

An addition to the system of indexing, such as was advocated by some of the railroad engineers, is specified. Each series of maps must be accompanied by a skeleton map which will show by outline the sheets of the series. The skeleton may be either on the first sheet of the series or on a separate sheet of standard size. Only the first sheet of a series must be certified before a notary public, but all sheets in the series must be identified as a part of the series, and all sheets must be signed by the engineer.

Less is required than originally specified in the way of information as to surrounding property. Only those property lines of adjacent landowners that intersect the railway base line are called for, the same being true of divisional land lines. Furthermore this information as to adjacent landowners, as well as the absolute direction of cardinal points, and sundry other data, is required only in so far as it can be supplied without additional surveys.

The much-opposed table of quantities for each mile on the profile is still required on future work. Its inclusion on profiles of existing lines is optional with the carrier, and is not specified in detail, the railroad being allowed to use its own classification.

Numerous minor changes are found throughout the specifications, these being in general in the interest of clearness and in accordance with suggestions made by the carriers. The pamphlet includes an appendix giving the Congressional enactment ordering the evaluation.

Book Reviews

Having withdrawn from the Associated Engineering Societies, the Boston Society of Civil Engineers has begun the publication of its own "Journal." The January number is its first issue. The first part of the paper is devoted to minutes of meetings and other items of interest to members of the society. The description of new engineering work contemplated or under construction will be a feature of every issue. In this number there are four pages of such news. The greater part of the "Journal" is taken up by the paper by J. R. Worcester, member of the society, on "Boston Foundations," presented at the meeting of Jan. 28. This paper consists of 29 pages and 26 plates. The "Journal" is to be published monthly, except July and August, at a subscription price of $4 per year, single numbers being 50 cents each. (Boston, Boston Society of Civil Engineers.)

Vacuum Cleaning Systems. A Treatise on the Principles and Practice of Mechanical Cleaning. By M. S. Cooley, Mechanical Engineer in Office of the Supervising Architect, Treasury Department, Washington, D. C. Cloth, 6 x 9 in.; 244 pages; 105 illustrations, 20 tables. New York, Heating and Ventilating Magazine Company. $3.

Mr. Cooley's seven years of experience in the preparation of specifications for, and the testing of, complete vacuum-cleaning plants in the buildings under the control of the Federal Treasury Department furnished the groundwork for this pioneer volume. The first chapter, beginning with the carpet sweeper, follows the history of mechanical cleaning through the use of compressed air and the piston pump to the development of stationary multi-stage turbine blowers. The next topic considered—the requirements of an ideal vacuum cleaning system—approaches more nearly the subject of design than does any other division of the book. The author has stated, indeed, that his aim has been to offer his own conclusions to the consulting engineer, without entering into the problems of design and manufacture.

Succeeding chapters deal with the carpet renovator and other types, stems and handles, hose, pipe and fittings, separators, vacuum producers, control, scrubbing systems, selection of cleaning plant, tests, specifications, and portable vacuum cleaners.

The "Mechanical World" Pocket Diary and Year Book for 1914. Cloth, 4 x 6½ in.; 443 pages; 71 illustrations. Manchester, England, Emmott & Company, Ltd.; Baltimore, Norman & Remington, 25 cents.

The "Mechanical World" Electrical Pocket Book for 1914. Cloth, 4 x 6½ in.; 311 pages; 129 illustrations. Manchester, England, Emmott & Company, Ltd.; Baltimore, Norman & Remington. 25 cents.

These two small publications contain definitions of units, working laws and formulæ, diagrams and tables in their respective fields, which they cover thoroughly. The diary is the more general work. Besides the subjects within the ordinary province of the mechanical engineer, it refers to the elements of structural and hydraulic design. Sections on milling and gear cutting on the milling machine and tables on hydraulic packing, copper expansion joints, dimensions of keys and weights of specials are among the new features of the 1914 edition.

New sections in the electrical pocketbook include those on telephones, electrical equipment of ships, lifting magnets, dry batteries, sparking distances in air and burglar alarms.

Each book contains the usual logarithmic and similar tables. The volumes are to be commended to engineers and others whose duties require quick reference on many subjects.

Text-Book on Highway Engineering. By Arthur H. Blanchard, Professor of Highway Engineering, Columbia University, and Henry B. Drowne, Instructor in Highway Engineering, Columbia University. Cloth, 6¼ x 9 in.; 761 pages; 234 illustrations and 4 charts. New York, John Wiley & Sons, Inc. $4.50 net.

The authors have accomplished a very desirable achievement by bringing the subject of highway engineering up to date. None of the books on roads and pavements has been thoroughly revised or has covered the entire subject for the last decade, so that it is with distinct pleasure that the engineer and teacher can pick up a work that at least strives to cover the whole field of highway engineering in the light of the present knowledge.

In their first chapter they have added a delightful and satisfying feature by giving to the reader and student a brief but sufficiently comprehensive history of the early development of streets and highways. It adds to the interest of the student and the practical man to know something of the beginnings and development of the subject he has in hand.

In the next two chapters the authors cover the preliminary investigations and the surveying and mapping of roads. Under preliminary investigations they present quite completely the methods of taking and the data of traffic census. The chapter on surveying and mapping, however, is too elementary and out of place for the practising engineer, and altogether useless for the student who is given a much more comprehensive training in these subjects in his regular courses in plain and railroad surveying and in the various courses in drawing provided in his freshman and sophomore years. Two or three paragraphs upon plans, profiles and setting line and grade stakes would be permissible.

In the chapter on design the various features, such as the effect of traffic, width, grade, alignment and crown, are treated in a very excellent manner. The rectangular and circumferential plans of street layout are illustrated and briefly discussed, but a more comprehensive discussion of street and highway layout with reference to the convenience to the travelling public, the effect on property valuations, drainage, garbage collection, beautification and many other phases of use would have added much value to this chapter. The chapters on drainage and foundations are very well covered.

In Chapter 7 there seems little reason for the two or three pages on classification of soils, and the description of the "Method of Operation" of many of the simpler tools used in grading is a positive waste of paper, printing and reader's time. The chapters on gravel and broken-stone roads are excellent. Strength would have been added by a more detailed description of the application of the binder and the compacting of the several courses. Six chapters, 242 pages, are devoted to bituminous materials, their tests, and use in various forms of pavements. A very complete nomenclature and description and interpretations of tests are given. Dust prevention is fully treated in this division.

A very full description and many illustrations are given of devices for forming bituminous surfaces. The penetration and mixing methods of making bituminous macadams and concretes are fully described. Under bituminous macadam many specifications are quoted but few comments are made as to the varying results that may be obtained under the different specifications and manipulations; the student and engineer are left to experiment and try out for themselves. The court decision on the suit of certain proprietary claims against the city of Topeka, Kansas, for infringing their patents in constructing bituminous macadam, is cited here for the benefit of the public.

The chapter on sheet asphalt pavements is particularly valuable to the engineer, giving much valuable data, specifications and instruction. A chapter, each, is devoted to wood, stone and brick block and to concrete and to miscellaneous pavements. They are treated in a fairly comprehensive manner, although by no means as completely as the bituminous surfaced streets, as is shown by the 242 pages given to bituminous surfaces as against 103 pages to the rest of the pavements. The paragraph given in each chapter to the "development" of the particular class of pavement under discussion is a pleasing and helpful phase of the book.

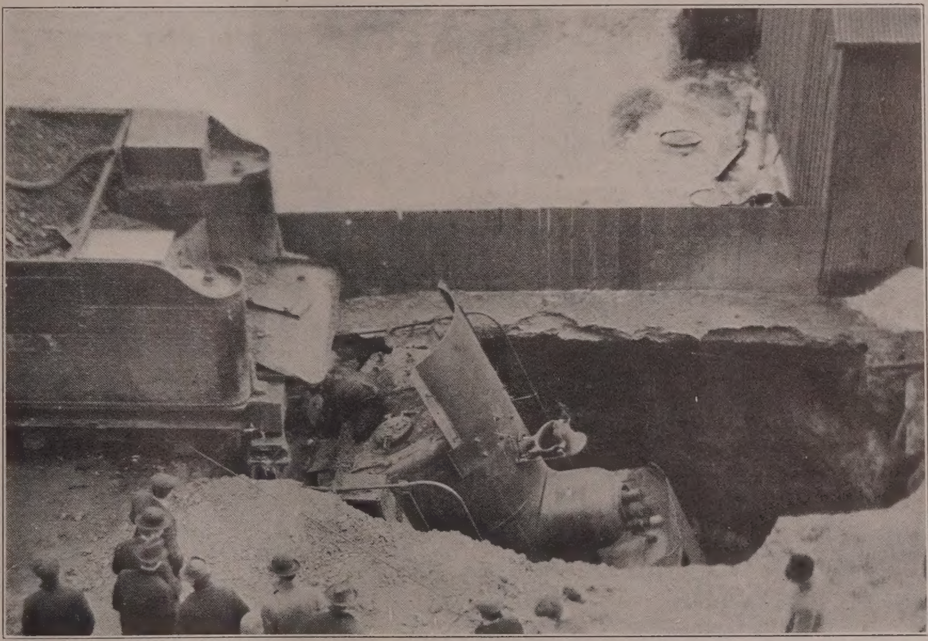
Separate chapters are given to street cleaning, car tracks, pipe systems, comparisons of road surfaces, sidewalks, bridges and culverts, and economics and administration. The chapter upon car tracks is particularly acceptable as meeting a need both in instruction and in practice. A very excellent map record of underground conduits and surface appurtenances is shown at the end of Chapter 23. A more detailed description of handling the back filling in trenches and repaving over the same would have been desirable, and a discussion of the economic solution of improving back country roads or what might be termed roads of the third class, would have have helped many a county engineer, located, so to speak, in the back woods. Altogether the book is a fair presentation of the engineering and construction features of highways and city pavements brought up to date and is well worth a place in the highway engineer's library.

Letters to the Editor

When the Bottom of the Street Drops Out

SIR: According to the school books the earth has a pretty thick and solid crust except where a volcano is in business. There is another exception, however, and this is in the anthracite coal-mining districts. For here the foundation support of the streets, alleys, buildings and farms is very thin indeed—in spots. The accompanying photograph shows the predicament of a locomotive that was going about its business in the usual way in Pittston, Pa., when its nose dropped 15 ft. into a mine cave, and of course its body had to follow. Houses, animals, men, women and children have experienced drops of the same kind, but this is the first time for a locomotive to take the dip. X.

Scranton, Pa.



Locomotive which Broke through Surface and Fell into a Coal Mine

Cracking of Bronzes and Brasses

SIR: In the Engineering Record of November 8, 1913, there was printed an article by the undersigned on "Cracking of Bronzes and Brasses." The last paragraph began with the sentence: "Defects of the kind described above have been found in both manganese and Tobin bronze." Exception has been taken to this statement by the manufacturers of the latter metal. The facts appear to be these: That the name Tobin bronze is laxly used in the trade to represent not only true "Tobin" bronze, manufactured solely by the American Brass Company, which controls this name as a trade designation, but also alloys of the same or very similar composition, more properly included under the general term naval brass. Numerous examples of cracked naval brass were found. It has, however, been difficult to identify the sources of some of this material, and but little metal has been positively identified as Tobin bronze. Of this quantity none has yet been found cracked.

This cracking of drawn and rolled bronzes and brasses is of such importance as to deserve the earnest attention of both manufacturers and users. The defect is the more dangerous because not immediately developed and not discoverable by the ordinary methods of inspection and test.

ALFRED D. FLINN,
Department Engineer, Board of Water Supply.
New York City.

Duplicated Educational Facilities

SIR: In an editorial note on page 121 of the Jan. 31 issue of the Engineering Record I notice a slight error of statement, namely, that in the State of Montana the engineering work has been transferred from the agricultural college to the University of Montana. The fact of the matter, however, is that the work in engineering has all been transferred from the university to the agricultural college, with the exception of the work in mining engineering, which is all to be given at the school of mines.

The error in your report, however, does not affect the thought of the editorial, and arose very naturally from the following circumstance: The University of Montana (at Missoula), the State College of Agriculture and Mechanic Arts (at Bozeman), the School of Mines (at Butte) and the State Normal School (at Dillon) have this year either been consolidated or are about to be consolidated in management to this extent: They are all to be controlled by a single board of trustees or regents, and the total organization is to be entitled the University of Montana. Thereupon all engineering work, as mentioned above, will be restricted to the agricultural college portion of said university. Certain transfers of members of the faculty from Missoula to Bozeman in accordance with this arrangement have been announced, and I think that the consolidation—if it should be called that—is already in operation.

My information is presumably correct, as we here are comparatively near neighbors to Montana, which State adjoins our own, although the university at Missoula is actually about 1000 miles from my own location.

E. F. Chandler,
Professor in Charge of Civil Engineering Course.
University of North Dakota.

Sir: I very much approve of your editorial, page 121 of the issue of the Engineering Record of Jan. 31, on "Duplicated Educational Facilities." This editorial, however, contains a misstatement of fact. You state, "The State of Montana has seen the absurdity and has transferred its engineering work from the Agricultural College to the University of Montana." The facts in the case are that the State of Montana has transferred its engineering work from the university to the State Agricultural and Mechanical College at Bozeman.

A great many of the Western states are wasting money, as you state, by supporting two institutions, giving ostensibly identical courses of instruction. In cases where there is both a State university and a State agricultural and mechanical college, I believe that the instruction in engineering should be given at the State College of Agriculture and Mechanical Arts, as it has appropriations from the Federal Government for carrying on this work.

R. E. Chandler,
Dean, Oklahoma Agricultural and Mechanical College.
Stillwater, Okla.

The Fetish of Formulæ

Sir: In your issue of Jan. 10, 1914, among letters to the editor is one from J. C. Prior, of Columbus, Ohio, showing one of the paradoxes resulting from the usual method of calculating an eccentrically riveted joint. A four-rivet symmetrical connection is shown to be just as strong as another connection with seven rivets added eccentrically. A six-rivet connection is shown to be weaker than the same connection with two rivets omitted. A note by the Editor states that the mathematics of the calculations is correct, or rather rational, and on the side of safety and employed by the best of engineers.

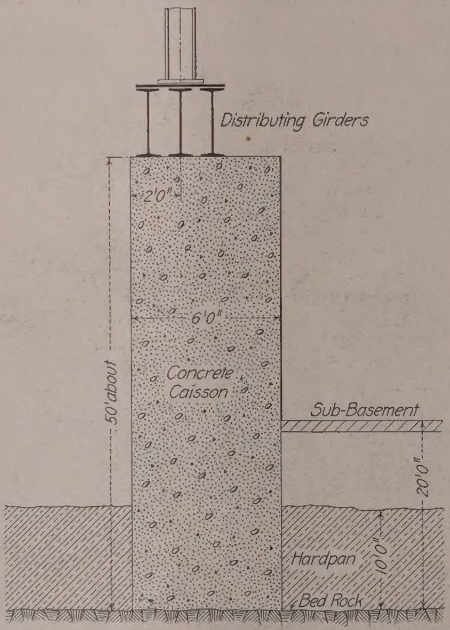
Let us suppose that the six-rivet connection has been already fabricated. Such a case was not at all unusual, as a gusset is sometimes made eccentric on one side to provide for connection of some unimportant member, say a small girt. The point in question is this: Would any competent engineer maintain that the connection was weak and that the proper way to strengthen it would be to cut out two rivets? I am afraid there are many men who would take this very stand.

It would seem to me that whenever there are sufficient rivets symmetrically placed in a connection to take up the stress delivered to it and there is nothing to show that the additional unsymmetrically placed rivets in any way prevent such a distribution, then it is idle to attempt to prove the contrary with any formula. Whenever a formula results in an answer which is manifestly opposed to horse sense, then the only thing that is proved is that the formula is an imperfect expression of actual facts.

Very few formulæ, if any, in applied mechanics are universally true. Even the most superficial examination of the column formulæ in use will convince any engineer of this, and yet there is a tendency to follow formulæ slavishly without due regard to their very questionable derivation.

Some time ago the writer had occasion to design foundations for a thirty-six-story building. The footings, as can be seen from the sketch, consisted of distributing girders resting on a 6-ft. wide caisson about 50 ft. deep running through about 10 ft. of hardpan to rock.

The column center was 2 ft. from one edge of the caisson, and the latter had some vertical and horizontal reinforcement in the top 15 ft. of its height. This reinforcement was not put in because the writer thought it essential but to comply with the New York building department regulations, which require reinforcement where 25 tons bearing on concrete is used. The distributing girders were 3 ft. 6 in. wide, 1 ft. 9 in. each side of the column center. This arrangement, giving a bearing value of 3½ x 25, or 87½ tons per running foot, took care of the loads nicely.



Eccentrically Loaded Pier

Had the foundations been built just 4 ft. wide there never would have been any criticism of the design, as 25 tons per square foot bearing on the rock and concrete is a moderate load. But a pneumatic caisson cannot be built 4 ft. wide. At least 6 ft. are required to give a practical working chamber underneath.

The engineer for the consulting architect, as well as the engineer for the contractor, both of them men of vast experience and unquestionable ability, immediately condemned the design because it was eccentric. Both of them agreed that the 4-ft. caisson would be satisfactory were it practical to sink it, but that the 6-ft. caisson was weak. There was no question of the caisson tilting due to the alleged unequal pressure on the rock—no anxiety was felt about the rock. The question was purely whether or not a wall was weakened by adding 2 ft. to it. The two engineers took the affirmative side of the question and the writer the negative. The bending moment was shown to be 1 ft. times the load on the column (column load about 4,000,000 lb.), and from this moment the varying pressures on the concrete were obtained in the usual manner.

Had the caisson been 10 ft. wide the case would have been worse, and had it been a mile wide it could have been proved to be rotating like a Fourth of July pinwheel. However, the majority won and the design was abandoned.

The design which was built, of course, retained the 6-ft. caisson, but the criticism of eccentricity was overcome by placing the distributing girders in the middle of the caisson and putting a cantilever girder on top of the distributing girder to receive the column. These cantilevers, of course, were not only a big additional expense but wasted a great deal of headroom.

The word eccentricity seems to be a sort of bugaboo. Eccentricity should always be investigated, of course, but it should be clearly shown that there is a tendency for rotation before any elaborate calculations are attempted. Formulæ should be used as a means of solving problems, not as a fetish.

Philadelphia. David Gutman.

Mixed vs. Penetration Roads

Sir: I was interested in reading the editorial in your issue of Jan. 24, page 89, on mixed versus penetration bituminous roads. I have just read, in the issue of Feb 7, page 175, the letters called forth by this editorial.

In New York State there were built, under my supervision, in 1909, about 100 miles of bituminous macadam roads and in 1910 about 700 miles—practically all by the penetration method. The Hudson-Hollowville road, of which Clifford Richardson writes, is one of these, built in 1909. I have suggested upon various occasions that a full report of the present condition of these roads would be of great value to the highway engineer. There is not in any other part of the United States or in any other country to-day so great a mileage of bituminous macadam roads. They have been built and under traffic for from four to five years and I have yet to see any definite report made of their condition. In these roads may be found bitumen furnished by practically every company in the business at that time. The bitumens used were not trade articles but filled definite specifications drawn by myself. Nearly every variety of stone to be found within the borders of the State may be found in these bituminous-macadam roads.

If someone else does not make a full and fair report on these roads during the coming season, it is my present intention to try and do so. The information should be very valuable.

T. Warren Allen,
Engineer Commissioner, New York State Highway Department, 1909-11.
Washington, D. C.

Earth Slides in the Canal Banks of the North Shore Channel of the Chicago Sanitary District are estimated to amount to 50,000 or 60,000 cu. yd. every winter. This is on a channel 8½ miles long and is equivalent to 6 or 7 in. of sloughing of the sides, without considering any additional quantities that may come from caving or slides of some magnitude. The material is being excavated and disposed of in a clay hole alongside the channel, dumped 8 miles out in the lake, or in rough weather dumped in Wilmette harbor and subsequently raised by a hydraulic dredge to adjacent park areas.